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**General Technical Report
RM-GTR-287**

A Classification of Forest Habitat Types Southern Arizona and Portions of the Colorado Plateau

Esteban H. Muldavin, Robert L. DeVelice, and Frank Ronco, Jr.

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ABSTRACT

A classification of forest habitat types, as defined by plant associations, is presented for coniferous forests south of the Mogollon Rim and portions of the Colorado Plateau in Arizona. The study area includes the Tonto, Prescott and Coronado National Forests; and the Fort Apache, San Carlos and Hualapai Indian Reservations. From a sample of 312 reconnaissance plots, a total of 49 habitat types are defined within eight climax forest tree series. Descriptions for each habitat type are provided along with tables to portray the ecological distribution of characteristic species. Information on soils, successional trends, management implications, and relationships to other habitat types of the Southwest is also given for each habitat type. A key based on indicator plant species is provided for field identification of the habitat types. General environmental relationships among habitat types within three major physiographic regions of Arizona are discussed.

Keywords: forest habitat types, plant associations, ecological distribution, coniferous forests, characteristic species

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A Classification of Forest Habitat Types Southern Arizona and Portions of the Colorado Plateau[1]

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A Classification of Forest Habitat Types Southern Arizona and Portions of the Colorado Plateau

Esteban H. Muldavin, Robert L. DeVelice, and Frank Ronco, Jr.

INTRODUCTION

Forest lands of southern Arizona have extensive timber, livestock, wildlife, water, and recreation resources. Effective management of these forest resources requires a thorough understanding of how different land units respond to different management practices and natural impacts. Toward this end, a habitat type classification has been developed for forests south of the Mogollon Rim and portions of the Colorado Plateau to provide a simple yet effective framework for summarizing forest ecosystem complexity to facilitate management.

Habitat type classifications are based on the concept that climax natural vegetation integrates all impinging environmental factors (Daubenmire 1976), and may thus provide a framework for easily observable ecosystem indicators. The natural vegetation of a landscape is classified into fundamental units of plant associations, based on differential species composition. Land units capable of supporting a given plant association at climax are defined as the same habitat type (Daubenmire 1968). A habitat type can be defined by such environmental characteristics as soils, landform, and position in local and regional landscapes. A given habitat type encompasses a relatively narrow range of biotic potential and, thus, a relatively narrow range of management options.

Currently, more than 30 habitat type classifications are available in the western United States as summarized by Pfister (1981). Growing use of these classifications throughout the West supports the value of the habitat type classification system for providing an ecologically based method of delineating ecosystems (Layser 1974). Additionally, habitat types provide a common system for improving communication among diverse investigators and aid in improving sampling design and experimental layout (Pfister et al. 1977).

In the Southwest, habitat type classifications have been completed for southern Colorado, New Mexico, and Arizona (Alexander et al. 1984a, 1984b; 1987; DeVelice et al. 1986; Fitzhugh et al. 1987; Hanks et al. 1983). These classifications are of limited usefulness in forests south of the Mogollon Rim because these forests have a strong Sierra Madrean floristic component that is poorly represented or absent in other areas of the Southwest. Moir and Ludwig (1979) described mixed conifer and spruce-fir forests in the area, but did not sample *Pinus ponderosa, P. leiophylla,* or *P. engelmannii* forests.

There have been intensive studies of the vegetation of individual mountain ranges in Arizona. Blumer (1909) and Sawyer and Kinraide (1980) sampled vegetation in the Chiricahua Mountains. Shreve (1919) and Martin and Fletcher (1943) described vegetation patterns in the Pinaleno Mountains. Whittaker and Niering (1964, 1965, 1968a, 1968b) and Niering and Lowe (1984) sampled vegetation in the Santa Catalina Mountains and broadly defined community types based on gradient analysis. Wallmo (1955) described forest communities of the Huachuca Mountains. These studies generally were confined to limited areas or did not attempt to classify the forests into units of similar vegetation. The exception is Brown et al. (1979), who have provided a framework for classification of all vegetation in the Southwest. Currently, this classification is primarily applied at the series level and above.

Our purpose here is to describe, as comprehensively as possible, all forest communities south of the Mogollon Rim and portions of the Colorado Plateau at the level of the habitat type (plant association), or lower (phase) if possible. This report incorporates data from the eastern Coronado National Forest (DeVelice and Ludwig 1983); the western Coronado, Tonto and Prescott National Forests (Muldavin et al. 1986a); and the San Carlos, Fort Apache, and Hualapai Indian Reservations (Muldavin et al. 1986b).

STUDY AREA

The study area encompasses most of the forested areas south of the Mogollon Rim in Arizona and portions of the Colorado Plateau. The areas included are those that support one or more of the following coniferous tree species: *Picea engelmannii, Abies lasiocarpa, Picea pungens, Abies concolor, Pseudotsuga menziesii, Pinus ponderosa, Pinus engelmannii,* and *Pinus leiophylla.*

Physiography

The study area is conveniently delineated into three physiographic regions: the Basin Ranges, Central Highlands, and the Plateau (fig. 1). These correspond respectively to the Southeast, Central, and Plateau geographic sections outlined by Sellers and Hill (1974).

Basin Ranges Region

This region of southeast Arizona falls within the larger Mountain or Mexican Highlands Section of the Basin and Ranges Physiographic Province described by Wilson (1962) and Hayes (1969). Since our study is confined to the mountainous areas only, we have simplified the name to Basin Ranges Region. It is characterized by steep, rugged, north to northwest trending fault block and volcanic ranges separated by wide, aggregated desert basins. Ranges studied include the Santa Catalina, Rincon, Santa Rita, Patagonia, Huachuca, Whetstone, Dragoon, Galiuro, Pinaleno, Santa Terresa, Peloncillo, and Chiricahua Mountains of the Coronado National Forest. Also included is the eastern Nantac Rim of the Nantanes Plateau of the San Carlos Indian Reservation. Elevations of study sites range from 5,500 to 10,700 feet (1,675 to 3,260 m). Geologically, these ranges are a complex mosaic dominated by volcanic rocks, primarily rhyolite, along with igneous intrusive and metamorphic rocks (granite, diorite, gneiss, and schist). Sedimentary limestone and sandstone rocks can also be intermixed.

Central Highlands Region

This area of central Arizona is characterized by eroded sedimentary and volcanic remnants of the Colorado Plateau (primarily sandstones and basalts of the Mogollon Plateau), and exposed Pre-Cambrian intrusives (granite and andesite). Hayes (1969) referred to this area as the Tonto Section of the Colorado Plateau Physiographic Province. Wilson (1962) considered it, in part, a transition zone between the Basin and Ranges and the Colorado Plateau Physiographic Provinces, and as part of a Mountain Region of the Basin and Ranges Physiographic Province. Major mountainous areas studied include the Bradshaw Mountains and Juniper Mesa of the Prescott National Forest; the Mazatzal and Pinal Mountains, and the Sierra Ancha of the Tonto National Forest; along the base and face of the Mogollon Rim of the Tonto National Forest and Fort Apache Indian Reservation; and the western Nantanes Plateau of the San Carlos Indian Reservation. Elevations studied range from 5,000 to 7,800 feet (1,525 to 2,380 m).

Plateau Region

This region of northern Arizona comprises the southern edge of the Colorado Plateau Physiographic Province described by Hayes (1969) and Wilson (1962). It includes the Mogollon Plateau, the Coconino Plateau, and the White Mountains. This study covers only the sedimentary Aubrey Cliffs portion of the Coconino Plateau on the Hualapai Indian Reservation, and the basaltic White Mountains on the Fort Apache Indian Reservation. Elevations studied range from 6,000 to 11,400 feet (1,830 to 3,475 m).

Climate

The general climatic parameters of each physiographic region are presented in table 1. The Basin Ranges Region tends to be warmer and drier than the other two regions. Note the high percentage of summer ("July") precipitation in the Basin Ranges. This is a reflection of the summer "Arizona Monsoon" rains which are most strongly felt in the southeast corner of the state and diminish in frequency and intensity westward. The Central Highlands Region, by contrast, is cooler and wetter, but precipitation occurs predominantly in winter as a result of sustained winter storms moving inland from the Pacific Ocean. The Plateau Region is the coldest and wettest of the three regions and it has a tendency towards a dominance by summer precipitation.

METHODS

Field Procedures

The development of the habitat type classification follows the concept as outlined by Daubenmire (1952,

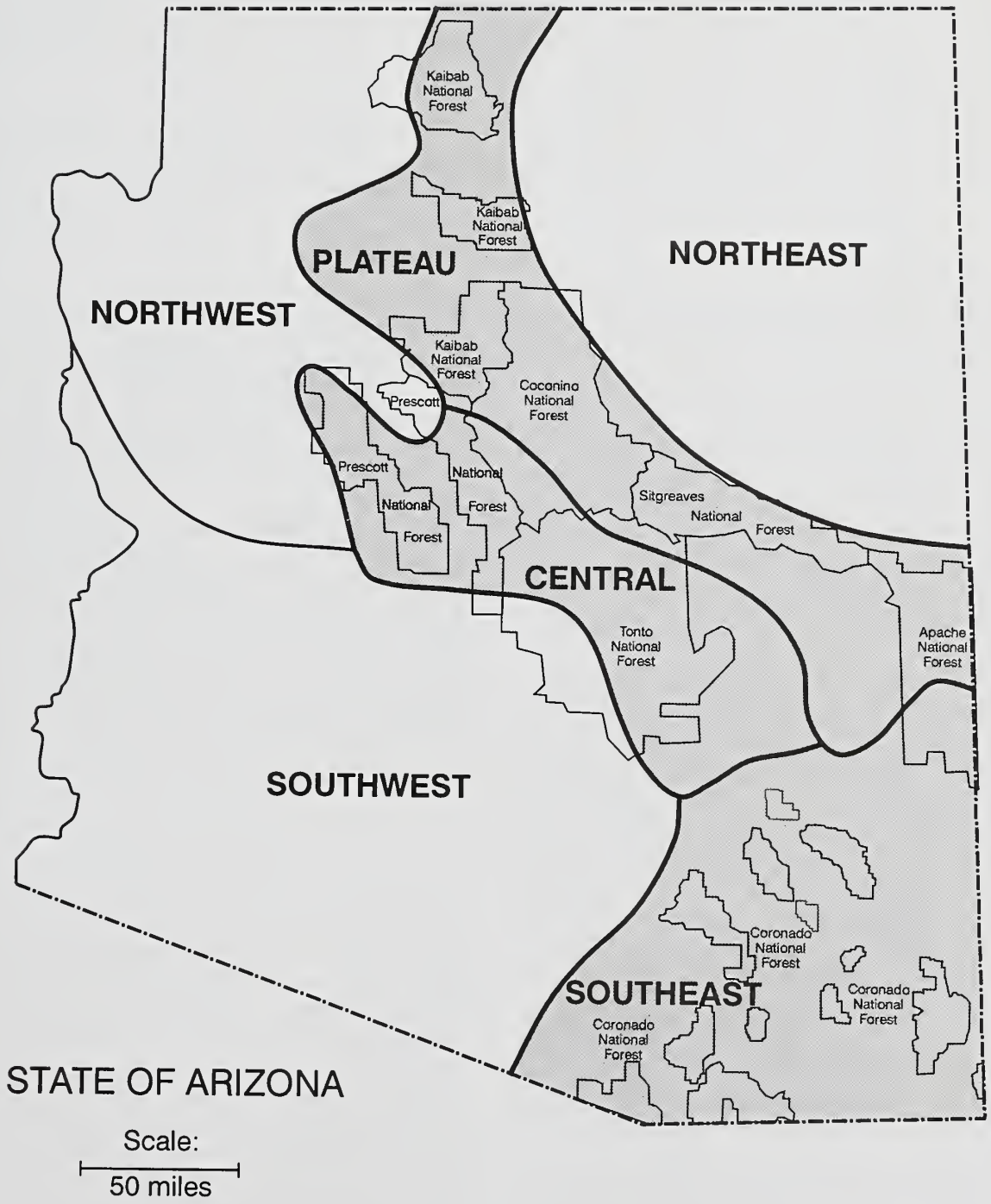

Figure 1.—Physiographic regions of the study area (Sellers and Hill 1974).

Table 1. Climate parameters for the three major physiographic regions of the study area.

Region	Mean Annual[1] Precip. (in.)	Mean Percent[2] Winter Precip. (in.)	Mean July[3] Temp.(8,000 ft) (C)	Mean January[4] Temp.(8,000 ft) (C)
Plateau	19.4	45	14.4	−3.3
Central Highlands	18.9	55	15.5	−1.2
Basin Ranges	14.4	35	16.7	+0.6

[1]*Sellers and Hill (1974).*
[2]*Extrapolated from maps of Carlston and Brown (1983).*
[3]*Derived by applying a summer lapse rate of 5.5 degrees Celsius per 1000 feet of elevation to regional weather station data of Sellers and Hill (1974).*
[4]*Derived by applying a winter lapse rate of 4.0 degrees Celsius per 1000 feet of elevation to regional weather station data of Sellers and Hill (1974).*

1976). Specific methodologies used in sampling and analysis follow Moir and Ludwig (1983) and Pfister and Arno (1980).

Prior to beginning field work, a literature search dealing with historical land use and ecology of forests in the study area was undertaken (Muldavin et al. 1983a). In addition, Forest Service personnel within specific ranger districts were interviewed for information available from unpublished reports and resource management maps. Using this background information, a specific strategy for studying the forests of the study area was formulated (Muldavin et al. 1983b).

Sample plots 375 square meters in size were established within stands of climax or near-climax vegetation. Areas severely overgrazed, harvested, treated with herbicide, mechanically disturbed, artificially seeded, or irrigated were not sampled. Plots were restricted to portions of stands that appeared relatively uniform with regard to topography and vegetation structure and composition. Efforts were made to locate plots to accurately represent tree and undergrowth composition, and visible site factors of the stand.

Both reconnaissance plots and analytical plots were included in the sample of plots at a ratio of about 4:1, respectively. Analytic plots were used to check and calibrate the accuracy of vegetation coverage as estimated by the reconnaissance plot method (Pfister and Arno 1980). Plot information included density of tree species in 2-inch diameter breast height (d.b.h.) classes; visually estimated percent cover of shrubs and herbs; and site characteristics such as slope, aspect, elevation, and topography. Soil profiles were described from pits dug in the center of each plot. Soils were classified to the subgroup level of soil taxonomy (USDA Soil Conservation Service 1975). Age, height, and d.b.h. were measured from as many as three open-grown trees in each plot for site index determinations. Plots were located on 15 or 7.5 minute U.S. Geographic Survey topographic maps and documented with three photographs. (For details see Daubenmire and Daubenmire 1968, Franklin et al. 1970, Moir and Ludwig 1983, and Pfister and Arno 1980).

We established 312 plots throughout the study area. Table 2 outlines the distribution of plots by habitat type. Sampling was concentrated in habitat types that were under-sampled or not described in previous studies. Plots were geographically widely distributed to sample the range of variation within habitat types. There was no *a priori* allocation of plots by national forest, Indian reservation, or other administrative unit.

Data Analysis

At the end of each field season, plant voucher specimens were identified and field identifications were corrected. All floristic and site data were computer coded in a standard format used in previous habitat classifications in the Southwest (Alexander et al. 1984a, b, 1987; DeVelice et al. 1986; Fitzhugh et al. 1987).

The total set of 312 plots was analyzed using the successive approximation classification strategy outlined by Pfister and Arno (1980) and Moir and Ludwig (1983). Stand table manipulations (Shimwell 1971) and ordination (Pielou 1977) were used to develop the habitat type classification. Evaluation of the objective results obtained by quantitative analyses was tempered by subjective ecological judgment (Williams 1967).

Table 2. List of series, habitat types (HT), and phases (PH) of southern Arizona and portions of the Colorado Plateau.

Series Habitat Type	Abbreviation	Number of plots
Picea engelmanii Series		
Picea engelmannii/Moss	PIEN/Moss HT	1
Picea engelmannii/Carex foenea	PIEN/CAFO HT	2
Picea engelmannii/Acer glabrum	PIEN/ACGL HT	4
Picea engelmannii/Erigeron eximius	PIEN/EREX HT	2
Abies lasiocarpa Series		
Abies lasiocarpa/Moss	ABLA/Moss HT	2
Abies lasiocarpa/Vaccinium myrtillus	ABLA/VAMY HT	3
Abies lasiocarpa/Vaccinium myrtillus-Rubus parviflorus	ABLA/VAMY-RUPA HT	1
Abies lasiocarpa/Rubus parviflorus	ABLA/RUPA HT	1
Abies lasiocarpa/Erigeron eximius	ABLA/EREX HT	2
Abies lasiocarpa/Jamesia americana	ABLA/JAAM HT	1
Picea pungens Series		
Picea pungens/Juniperus communis	PIPU/JUCO HT	1
Picea pungens/Erigeron eximius	PIPU/EREX HT	1
Picea pungens/Festuca arizonica	PIPU/FEAR HT	2
Abies concolor Series		
Abies concolor/Vaccinium myrtillus	ABCO/VAMY HT	1
Abies concolor/Carex foenea	ABCO/CAFO HT	3
Abies concolor/Berberis repens	ABCO/BERE HT	7
Abies concolor/Acer glabrum	ABCO/ACGL HT	5
Abies concolor/Erigeron eximius	ABCO/EREX HT	
Valeriana arizonica phase	VAAR PH	2
Abies concolor/Quercus gambelii	ABCO/QUGA HT	8
Abies concolor/Acer grandidentatum	ABCO/ACGR HT	5
Abies concolor/Juglans major	ABCO/JUMA HT	1
Pseudotsuga menziesii Series		
Pseudotsuga menziesii/Sparse	PSME/Sparse HT	2
Pseudotsuga menziesii/Muhlenbergia virescens	PSME/MUVI HT	12
Pseudotsuga menziesii/Muhlenbergia montana	PSME/MUMO HT	1
Pseudotsuga menziesii/Quercus gambelii	PSME/QUGA HT	19
Pseudotsuga menziesii/Acer granditentatum	PSME/ACGR HT	2
Pseudotsuga menziesii/Quercus rugosa	PSME/QURU HT	6
Pseudotsuga menziesii/Quercus hypoleucoides	PSME/QUHY HT	5
Pseudotsuga menziesii/Quercus arizonica	PSME/QUAR HT	5
Pinus ponderosa Series		
Pinus ponderosa/Festuca arizonica	PIPO/FEAR HT	1
Pinus ponderosa/Muhlenbergia virescens	PIPO/MUVI HT	12
Pinus ponderosa/Muhlenbergia montana	PIPO/MUMO HT	3
Pinus ponderosa/Quercus gambelii	PIPO/QUGA HT	
Quercus gambelii phase	QUGA PH	9
Bouteloua gracilis phase	BOGR PH	12
Pinus edulis phase	PIED PH	6
Muhlenbergia longiligula phase	MULO PH	4
Pinus ponderosa/Bouteloua gracilis	PIPO/BOGR HT	
Bouteloua gracilis phase	BOGR PH	3
Artemisia tridentata phase	ARTR PH	1
Pinus ponderosa/Juglans major	PIPO/JUMA HT	4
Pinus ponderosa/Acer grandidentatum	PIPO/ACGR HT	2
Pinus ponderosa/Quercus rugosa	PIPO/QURU HT	10
Pinus ponderosa/Quercus hypoleucoides	PIPO/QUHY HT	22
Pinus ponderosa/Quercus arizonica	PIPO/QUAR HT	
Quercus arizonica phase	QUAR PH	29
Bouteloua gracilis phase	BOGR PH	5

continued on next page

Table 2 (continued). List of series, habitat types (HT), and phases (PH) of southern Arizona and portions of the Colorado Plateau.

Series Habitat Type	Abbreviation	Number of plots
Pinus ponderosa/Quercus emoryi	PIPO/QUEM HT	19
Pinus ponderosa/Arctostaphylos pungens	PIPO/ARPU HT	12
Pinus engelmannii Series		
Pinus engelmannii/Quercus rugosa	PINEN/QURU HT	1
Pinus engelmannii/Quercus hypoleucoides	PINEN/QUHY HT	6
Pinus engelmannii/Muhlenbergia longiligula	PINEN/MULO HT	
Muhlenbergia longiligula phase	MULO PH	1
Quercus arizonica phase	QUAR PH	1
Quercus emoryi phase	QUEM PH	1
Pinus leiophylla Series		
Pinus leiophylla/Quercus hypoleucoides	PILE/QUHY HT	10
Pinus leiophylla/Quercus arizonica	PILE/QUAR HT	6
Pinus leiophylla/Quercus emoryi	PILE/QUEM HT	7
Pinus leiophylla/Piptochaetium fimbriatum	PILE/PIFI HT	7
Pinus leiophylla/Arctostaphylos pungens	PILE/ARPU HT	9

Plots were grouped according to the tree species that showed the strongest evidence of self-perpetuation, i.e., the climax tree species. This is termed the "series" level of the classification (Hoffman and Alexander 1976). Each series was then subdivided based on the dominant or characteristic undergrowth species in the climax community. Thus, habitat type names are two-part. For example, the first part of the name in the *Pinus ponderosa / Quercus hypoleucoides* HT refers to the climax tree species, and the second part refers to the climax undergrowth indicator species (Pfister and Arno 1980). In some instances, the habitat type name may contain two undergrowth species separated by a hyphen to indicate that the habitat type is characterized by the occurrence of both species. Habitat types could be further subdivided into Phases (subassociations) which either represent floristic variants of typical habitat type (Typic phase), or potential habitat types for which there is not yet enough data available to recognize a distinct habitat type. Names were chosen for brevity and for appropriateness in conveying a sense of a given range of environmental conditions. The name does not imply that the only species in the stand are those given in the name. Codominance of two or more tree species at climax and the occurrence of 30 or more undergrowth species is common.

Site indices for *Pseudotsuga menziesii* and *Pinus ponderosa* were determined in habitat types where they were dominant or codominant using the curves of Edminster and Jump (1976) and Minor (1964), respectively. Timber productivity was rated as follows: *low* = site index 54 or less, *moderate* = 55–74, and *high* = 75 and above.

The final result is a classification of forest communities, hierarchically arranged by climax tree series, and then by habitat types. A dichotomous key to the habitat types, based primarily on vegetative characteristics, is included. Descriptions for each habitat type are provided which detail the vegetation composition and successional trends, physical setting, adjacent habitat types, ecotones, management implications, and relationships to other habitat type classifications in the Southwest and Rocky Mountains. Such descriptions must be considered as a first approximation because they are based only on the data gathered in developing the classification. More accurate elucidation of these relationships would require specifically designed studies. Furthermore, caution is necessary in relating the habitat types described here to those described in other areas; composition of the entire stand must be considered since the species complement varies geographically (Pfister 1972).

Taxonomic Considerations

Nomenclature follows Kearney and Peebles (1951) and Lehr (1978), except for revisions suggested in Weber and Johnston (1979) and Correll and Johnston (1970). Appendix A provides a comprehensive list of species and their synonyms identified in this study.

Certain species can be difficult to identify in the field. Particularly difficult was the identification of

Quercus arizonica versus *Q. grisea*, because a broad spectrum of hybrids were commonly found. Overall, *Q. arizonica* is more common than *Q. grisea* in the study area, particularly in the western part (Kearney and Peebles 1951). Since the two are more or less ecological equivalents, all specimens of this complex were lumped under the name *Q. arizonica* in the habitat type descriptions.

The closely related *Pinus ponderosa* var. *scopulorum* (three-needled fascicles) and *Pinus arizonica* (five-needled fascicles) both occur in the southern ranges of the study area. Generally, *P. ponderosa* is found at higher elevations than *P. arizonica*, but there can be a relatively broad zone of overlap and hybridization between the two (Dodge 1963; Peloquin 1971, 1984). For purposes here, the two species have been grouped together under *P. ponderosa*.

RESULTS

We described 49 habitat types among eight climax tree series within the study area (table 2). Layser and Schubert (1979) provide general series descriptions for Southwestern forests. Seven of the eight forest series they describe were found in the study area. In addition, a new *Pinus engelmannii* series is defined and described here.

Each habitat type is described in detail below. Most of the descriptions relate to nonriparian forests having soil profile development. Appendix B quantitatively summarizes the vegetation data by series and habitat type that the descriptions are based on. Appendix C outlines the successional trends of the various overstory trees by habitat type. In Appendix D, keys to the series and habitat types, along with instructions for field use, are provided.

Habitat Type Descriptions

Each habitat type description contains sections on geographical location, vegetation composition, physical setting, adjacent habitat types, and comments. A major habitat type is considered to be one that has been well-documented in this or other studies and is of major geographical significance within the study area. In contrast, a minor habitat type is one that is documented by less than five plots, or is of minor geographical significance.

Generally, the order of habitat types described is from cool and moist to warm and dry environments, roughly corresponding with high to low elevations.

Along with the full name of each habitat type, an abbreviation using species codes is given followed by the common name. "HT" stands for habitat type and "PH" for phase.

DEFINITIONS

The following adjectives and nouns used in the descriptions have specific meanings:

Plant Density or Coverage

Absent = species is not found in the habitat type.
Present = an associate of the habitat type.
Accidental = individuals are very infrequent, occasional, or limited to special microsites.
Abundant = canopy coverage > 25%.
Common = canopy coverage > 1%.
Scarce = canopy coverage < 1%.
Dominant = density or cover is as great as, or greater than, any other species of the same life form.
Luxuriant = canopy coverage > 50%.
Poorly represented = canopy coverage < 5%.
Well-represented = canopy coverage > 5%.

Ecological Temperature Regime

Cold = approximate mean annual temperature less than 42.5°F (5.8°C), and corresponds generally to the cryic soil temperature regime.
Cool = approximate mean annual temperature 45°F (7.2°C) and corresponds generally to the frigid soil temperature regime.
Mild = approximate mean annual temperature 50° F (10°C) and corresponds generally to the cooler end of the mesic soil temperature regime.
Warm = approximate mean annual temperature >55°F (>13°C) and corresponds generally to the warmer end of the mesic soil temperature regime.

Ecological Moisture Regime

Xeric = approximate annual precipitation ranges from 13 to 20 inches (33 to 50 cm), and corresponds roughly to the wet end of the xeric soil moisture regime and the very dry end of the ustic soil moisture regime.
Dry mesic = approximate annual precipitation from 20 to 25 inches (51 to 63 cm), and corresponds roughly to the dry end of the ustic soil moisture regime.
Mesic = approximate annual precipitation from 25 to 30 inches (64 to 76 cm), and roughly corre-

sponds to the moist end of the ustic soil moisture regime.

Moist mesic = approximate annual precipitation 30+ inches (77+ cm), and corresponds roughly to the udic soil moisture regime.

Life Forms

Graminoids = grasses and grasslike herbaceous plants.

Forbs = nongrasslike herbaceous plants.

Herbs = graminoids + forbs.

Shrubs = woody, multi-stemmed plants, usually less than three meters in height and lacking a tree-like form. Also, large spiny rosettes such as yucca or sotal.

Undergrowth = Graminoids + forbs + shrubs.

Picea engelmannii Series

This high-elevation series is characterized by a dominance of *Picea engelmannii* and an absence of *Abies lasiocarpa*. Representative habitat types of this series are relatively rare south of the Mogollon Rim. *Picea engelmannii*, while abundant in the White Mountains of the Plateau Region, reaches the southwestern limits of its distribution in the Pinaleno and Chiricahua Mountains of the Basin Ranges.

Picea engelmannii/Moss Habitat Type (PIEN/Moss HT; Engelmann spruce/moss)

Geographic location—This minor habitat type is restricted to the highest elevations of the Chiricahua Mountains of the Basin Ranges, and the White Mountains of the Plateau Region.

Vegetation—Picea engelmannii dominates the overstory and regeneration, and *Abies lasiocarpa* is absent. The undergrowth is very sparse and is characterized by soil mosses and only a few scattered low-lying shrubs (*Lonicera utahensis, Ribes montigenum,* and/or *Vaccinium myrtillus*), and few herbs.

Physical setting—This HT is found at elevations greater than 10,500 feet (3,200 m) on mountaintop ridges and upper slopes. Soils are very shallow and cobbly with cryic temperature regimes.

Adjacent habitat types—ABLA/VAMY or PIEN/ACGL are the most common adjacent habitat types and are usually found immediately downslope.

Comments—This HT was previously described by Moir and Ludwig (1979) as part of a habitat type that also included the ABLA/Moss HT. Fitzhugh et al. (1987) defined the PIEN/Moss HT without the presence of *Abies lasiocarpa* for southwestern New Mexico, which is the convention followed here.

The site productivity for timber is low because the soils are very coarse-textured (extremely cobbly), have a low nutrient status, and there is limited growing season indicated by the cryic soil moisture regime. Regeneration following harvest is unlikely to be successful, except in somewhat more sheltered sites. Since forage production and cover values are very low, there is little wildlife or livestock grazing potential.

Picea engelmannii/*Carex foenea* Habitat Type (PIEN/CAFO HT; Engelmann spruce/silvertop sedge)

Geographic location—The PIEN/CAFO HT is a minor habitat type restricted to the upper elevations of the Pinaleno Mountains of the Basin Ranges.

Vegetation—This habitat type is characterized by dominance of *Picea engelmannii*, or occasionally codominance with *Abies lasiocarpa*. Shrubs are scarce, and the rhizomatous *Carex foenea* in the undergrowth is diagnostic. The forb compliment can be diverse, but usually is not extensive in cover; the most constant herbs are *Campanula rotundifolia, Lathyrus arizonicus, Mertensia franciscana,* and *Oreochrysum parryi*.

Physical setting—This HT is found on moderately steep, south-facing, upper slopes and ridge lines above 10,000 feet (3,050 m). Soils are cobbly and skeletal and belong to the cryic temperature regime.

Adjacent habitat types—ABLA/VAMY and ABLA/EREX commonly occur along with habitat types of the *Abies concolor* or *Pseudotsuga menziesii* Series.

Comments—Moir and Ludwig (1979) originally described the PIEN/CAFO HT. It is a very restricted habitat type, and in our study, was found only on the west face of Mt. Graham. Regeneration of *Picea engelmannii* is difficult because of competition with *Carex foenea*, which increases significantly when the overstory is removed or is greatly reduced in density. The abundance of forage, however, provides good wildlife habitat.

Picea engelmannii/*Acer glabrum* Habitat Type (PIEN/ACGL HT; Engelmann spruce/Rocky Mountain maple)

Geographic location—This minor habitat type is restricted to high elevations of the Chiricahua Mountains of the Basin Ranges.

Vegetation—*Picea engelmannii* is the dominant tree species, with *Pseudotsuga menziesii* and *Abies concolor* as major and minor co-climax associates, respectively. *Populus tremuloides* is the major seral species and *Pinus strobiformis* is a minor seral species. *Acer glabrum* is well-represented in the undergrowth and is diagnostic. Other shrubs may include *Holodiscus dumosus, Lonicera utahensis,* and *Physocarpus monogynus.* Herbs can be sparse to well-represented; the common species are *Bromus richardsonii, Erigeron eximius, Fragaria americana, Ligusticum porteri, Senecio bigelovii,* and *Viola canadensis.*

Physical setting—This cold, moist mesic HT occurs on steep mid to upper, north and east-facing slopes. Elevation ranges from 8,900 to 9,500 feet (2,700 to 2,900 m). Soils are commonly Dystric Cryochrepts.

Adjacent habitat types—Adjoining habitat types may include the ABCO/ACGL and ABCO/BERE on somewhat warmer sites, and the PIEN/Moss on cooler upper slopes.

Comments—First described by Moir and Ludwig (1979). *Picea engelmannii* occurs at its southernmost limit within this type. The type has also been reported for the Sacramento Mountains of New Mexico (Alexander et al. 1984a).

Owing to its restricted area and low availability of forage, this type is of minor importance with respect to timber production and wildlife habitat (although seral stages dominated by *Populus fremontii* may provide important wildlife habitat).

Picea engelmannii/Erigeron eximius Habitat Type (PIEN/EREX HT; Engelmann spruce/forest fleabane)

Geographic location—This minor habitat type is restricted to the White Mountains of the Plateau Region. It is potentially present in the higher elevations of the eastern Basin Ranges Region.

Vegetation—In this habitat type where *Picea engelmannii* is the major climax species, followed by *Pseudotsuga menziesii. Picea pungens,* and *Abies concolor* can be minor climax or seral species. *Populus tremuloides* is the major seral species; *Pinus ponderosa* and *Pinus strobiformis* are minor seral species, particularly on the warmer sites. The undergrowth is characteristically herbaceous and often luxuriant with *Carex foenea, Erigeron eximius, Geranium richardsonii, Smilacina stellata,* and *Valeriana* spp. well-represented.

Physical setting—This cold, moist mesic habitat type is restricted to the lower sideslopes of canyon drainages at moderate to high elevations over 8,000 feet (2,440+ m), with northerly exposures. It is most likely to occur at the lowest elevation position of *Picea engelmannii.*

Adjacent habitat types—This HT may adjoin the PIPU/CAFO or PIPU/EREX HTs along drainages. Upslope, drier and warmer sites usually support mixed conifer forests of the *Abies concolor* and *Pseudotsuga menziesii* series.

Comments—This type has been described in detail by Fitzhugh et al. (1987) who reallocated the plots from New Mexico and Arizona in the *Picea pungens-Picea engelmannii/Erigeron superbus* habitat type of Moir and Ludwig (1979) to the PIPU/EREX and PIEN/EREX HTs. The PIEN/EREX HT is very similar to the PIPU/EREX HT described below, except for the abundance of *Picea engelmannii* reproduction and reduced shrub cover.

Mesic site conditions prevail in this habitat type, thus site productivity is moderate to high. Cutting will probably favor *Pseudotsuga menziesii* at the expense of *Picea pungens* and *P. engelmannii.* The high cover and forage values make this excellent wildlife habitat. In addition, the location of the habitat type along drainages enhances its importance for watershed and fisheries management.

Abies lasiocarpa Series

This series is typified by the dominance and successful reproduction of *Abies lasiocarpa* (Layser and Schubert 1979). *Picea engelmannii* is commonly a codominant climax species, but may be absent. *Populus tremuloides* is the major seral species following disturbance. *Pseudotsuga menziesii* can be a minor seral species in some of the lower elevation, warmer habitat types. These are high-elevation forests which, along with those of the *Picea engelmannii* series, are found between nonforested alpine vegetation and the mixed conifer forests of lower elevations. Habitat types of this series are common in the Rocky Mountains, but are relatively rare south of the Mogollon Rim.

Abies lasiocarpa/Moss Habitat Type (ABLA/Moss HT; subalpine fir/moss)

Geographic location—This minor habitat type is restricted to the highest elevations of the Pinaleno Mountains of the Basin Ranges, and to the White Mountains of the Plateau Region.

Vegetation—The overstory is codominated by *Picea engelmannii* and *Abies lasiocarpa.* The under-

growth is very sparse with scattered low-lying shrubs (such as *Lonicera utahensis*, *Ribes montigenum*, and/or *Vaccinium myrtillus*); moss is the dominant in the herbaceous layer.

Physical setting—The cold, dry ABLA/Moss HT is found at the highest elevations (9,800 to 11,500 feet or 3,000 to 3,500 m) of mountaintops, ridges and upper slopes. Soils are very shallow with cryic temperature regimes. Comparable soils elsewhere in the White Mountains have been described as Dystric Cryochrepts (Laing et al. 1989).

Adjacent habitat types—The ABLA/ VAMY HT is most common. The ABLA/EREX HT is occasional.

Comments—The ABLA/Moss HT is widely distributed and has been previously described by Moir and Ludwig (1979) for Arizona and New Mexico (they included the PIEN/Moss HT described above within the ABLA/Moss HT), by DeVelice et al. (1986) for southern Colorado and northern New Mexico, and by Fitzhugh et al. (1987) for southwestern New Mexico. It has also been reported in central Colorado by Dix and Richards (1976) and Komarkova et al. (1988).

Since the soils are very shallow and cobbly and the sites are cold and dry, site productivity for timber is very poor. Regeneration is unlikely to be successful, except in somewhat sheltered sites. There is little potential for wildlife or livestock because cover and forage are limited.

Abies lasiocarpa/Vaccinium myrtillus Habitat Type (ABLA/VAMY HT; subalpine fir/Rocky Mountain whortleberry)

Geographic location—This major habitat type is extensive at upper elevations of the White Mountains of the Plateau Region, and in the Pinaleno Mountains of the Basin Ranges.

Vegetation—*Picea engelmannii* and *Abies lasiocarpa* are co-climax dominants. In some stands, either one may be dominant, while the other is minor. *Pseudotsuga menziesii* is usually absent, or a minor seral species at lower elevations. *Populus tremuloides* can be a seral species, but succession is often direct to *Abies lasiocarpa* or *Picea engelmannii*. The undergrowth is characteristically dominated by *Vaccinium myrtillus*, with cover as high as 50% or more (fig. 2). Other shrubs are of minor importance but may include *Lonicera utahensis* and *Ribes* spp. Occasional herbs are *Bromus richardsonii*, *Carex* spp., *Festuca sororia*, *Osmorhiza depauperata*, *Oreochrysum parryi*, and *Ramischia secunda*.

Physical setting— This cold, mesic habitat type is found on gentle to moderately steep slopes of any aspect above 10,000 feet (3,050 m) in elevation. Typical sites are upper slopes and ridgelines where soils tend to be extremely cobbly or stony. The soil temperature regime is cryic. Fitzhugh et al. (1987) reported cold Dystric Cryochrepts, loamy skeletal, mixed mineralogy soils from this type in the White Mountains.

Adjacent habitat types—On higher elevation ridge tops of drier exposures, the ABLA/VAMY HT grades to the PIEN/Moss or ABLA/Moss HTs. On lower slopes where there is more available moisture, but the soils are still cryic, the ABLA/VAMY-RUPA can be found. The ABLA/RUPA or ABLA/EREX HTs may be found adjoining on lower, warmer sites.

Comments—This type is widespread at higher elevations of the Rocky Mountains and major mountain ranges of the Southwest. It has been previously described from the White Mountains of Arizona into the Mogollon Mountains of New Mexico (Fitzhugh et al. 1987), on Mt. Taylor in north central New Mexico (Alexander et al. 1987), and in the southern Rocky Mountains (DeVelice et al. 1986, Komarkova et al. 1988). Youngblood and Mauk (1985) also described the type for southern Utah, but the complement of forb species indicates a somewhat moister phase. The ABLA/VAMY HT is replaced by the *Abies lasiocarpa/Vaccinium scoparium* HT in the northern Rocky Mountains, but the two types share a consistent physiognomy and characteristic dominance of *Vaccinium spp.* (Hoffman and Alexander 1976, Komarkova et al. 1988, Peet 1981, Pfister 1972, Pfister et al. 1977, Steele et al. 1983, Wirsing and Alexander 1975). The southernmost occurrence of this type is in the Pinaleno Mountains of southern Arizona.

Timber productivity is low to moderate. Timber harvest favors *Abies lasiocarpa* in the replacement stand (Hoffman and Alexander 1976, Moir and Ludwig 1979). Regeneration response following logging may be slow due to competition from shrubs and to the short growing season. Fire is of minor importance in succession. Grazing potential is low because of limited forage resulting from shade by the closed canopy and the short growing season.

Deep snowpack is a characteristic feature of this type and can be an important element in watershed management since the type has extensive geographic coverage.

Abies lasiocarpa/Vaccinium myrtillus -Rubus parviflorus Habitat Type (ABLA/VAMY-RUPA HT; subalpine fir/Rocky Mountain whortleberry-western thimbleberry)

Geographic location—This minor habitat type is

Figure 2.—*Abies lasiocarpa/Vaccinium myrtillus* HT along an upper slope in the White Mountains at 10,100 feet (3,075 m). *V. myrtillus* forms a low-lying shrub cover across the forest floor. Overall species diversity is low.

found occasionally in the White Mountains of the Plateau Region.

Vegetation—*Abies lasiocarpa* and *Picea engelmannii* codominate in the climax overstory. *Populus tremuloides* and *Pseudotsuga menziesii* are major and minor seral species, respectively. *Vaccinium myrtillus* and *Rubus parviflorus* are the codominants in the shrub layer, with *Lonicera utahensis* and *Acer glabrum* often present. Herb coverage and diversity is moderate with *Erigeron eximius*, *Fragaria ovalis*, and *Geranium richardsonii* as common associates.

Physical setting—The cold, mesic ABLA/VAMY-RUPA HT is found on mid to lower slopes where soil moisture is greater relative to the ABLA/VAMY HT, and the soils deeper, but still cryic.

Adjacent habitat types—On cooler, higher elevation sites with deeper snowpacks, this HT adjoins the ABLA/VAMY HT. On warmer, wetter sites with deeper soils, it intergrades to the ABLA/RUPA or ABLA/EREX HTs.

Comments—The ABLA/VAMY-RUPA HT is more common to the north and east of the study area. It has been previously described by DeVelice et al. (1986) and Moir and Ludwig (1979) for Arizona and New Mexico, and for the southern Rocky Mountains. Fitzhugh et al. (1987) referred to the type as the ABLA/VAMY HT RUPA Phase in southwestern New Mexico. The ABLA/VAMY-RUPA HT, as represented here, is less luxuriant and diverse in the herb layer and does not contain *Arnica cordifolia*, a highly constant species in the southern Rocky Mountains. The presence of *Rubus parviflorus* and *Vaccinium myrtillus* together is considered diagnostic of an intermediate position between the ABLA/VAMY and ABLA/RUPA HTs.

Timber productivity is moderate. Clearcuts favor *Picea engelmannii*, while selection cuts favor *Abies lasiocarpa*. Caution is necessary because increased shrub cover following the opening of a stand may inhibit reproduction of conifers. There is moderate cover and forage for wildlife.

Abies lasiocarpa/Rubus parviflorus Habitat Type (ABLA/RUPA HT; subalpine fir/western thimbleberry)

Geographic location—This habitat type is of minor occurrence in the White Mountains of the Plateau Region.

Vegetation—*Picea engelmannii* and *Abies lasiocarpa* are climax codominants. *Populus tremuloides* and *Pseudotsuga menziesii* are potential major and minor seral species, respectively. The tall shrub stratum may have *Acer glabrum* and *Salix scouleriana*, with *Rubus parviflorus* conspicuous as the lower shrub dominant. *Actaea rubra* and *Lonicera utahensis* may also be common, but *Vaccinium myrtillus* is scarce or absent. The herb layer is diverse and luxuriant; common and abundant herbs may include *Bromus richardsonii, Erigeron eximius, Geranium richardsonii, Osmorhiza depauperata, Ramischia secunda, Smilacina racemosa, Smilacina stellata, Thalictrum fendleri,* and *Viola canadensis.*

Physical setting—This is a cold, mesic habitat type found at elevations from 8,000 to 10,000 feet (2,440 to 3,050m), on steep, mid and lower slopes, or in ravines or stream side terraces. Soils of this type have been described by DeVelice et al. (1986) and Fitzhugh et al. (1987) as alfisols or molisols with cryic temperature regimes. The Terrestrial Ecosystem Survey (Laing et al. 1989) also describes cryic soils within the range of this habitat type.

Adjacent habitat types—On cooler sites the ABLA/EREX, ABLA/VAMY-RUPA, or the ABLA/VAMY HTs may be found. Warmer sites usually have mixed conifer forests of the *Abies concolor* or *Pseudotsuga menziesii* series.

Comments—This type has been previously described in detail for New Mexico and southern Colorado by DeVelice et al. (1986), Fitzhugh et al. (1987), and Moir and Ludwig (1979).

The diversity of forage and high cover makes this excellent wildlife habitat, particularly for elk, deer, and black bear. Site quality is moderate to good for *Abies lasiocarpa* and *Picea engelmannii* (Moir and Ludwig 1979), but steepness and close proximity to stream channels can pose hazards for timber harvest. Clearcuts will favor *P. engelmannii*, and selection cuts favor *A. lasiocarpa.*

Abies lasiocarpa/Erigeron eximius Habitat Type (ABLA/EREX HT; subalpine fir/forest fleabane)

Geographic location—This major type is common in the White Mountains of the Plateau Region.

Vegetation—*Abies lasiocarpa* and *Picea engelmannii* are overstory climax codominants, with *Populus tremuloides* and *Pseudotsuga menziesii* as major and minor seral species, respectively. Other possible minor seral tree species include *Picea pungens, Abies concolor,* and *Pinus strobiformis.* Shrubs are of minor importance in this type, and *Vaccinium myrtillus* is rare or absent. The ABLA/EREX HT is characteristically herbaceous with a diverse, often luxuriant forb component. The common dominant is *Erigeron eximius* usually in association with *Carex foenea, Fragaria* spp., *Geranium richardsonii, Ligusticum porteri, Luzula parviflora, Osmorhiza depauperata, Ramischia secunda, Smilacina racemosa, S. stellata,* and *Viola canadensis.*

Physical setting—The cold, moist mesic ABLA/EREX HT is usually found above 9,500 feet (2,900 m) on a wide variety of slopes and aspects, tending toward mid to upper slopes with cool aspects. Annual precipitation is above 30 inches (76 cm), with approximately 50% being snowpack (Beschta 1976). Soils from this type in southwestern New Mexico were described by Fitzhugh et al. (1987) as moderately deep and of the cryic soil temperature regime. Overall, soils vary in depth and texture within this HT, and have been described and mapped within the nearby Apache-Sitgreaves National Forests (Laing et al. 1989).

Adjacent habitat types— On high, colder sites there may be a complicated mosaic with the ABLA/VAMY HT, shifting with local topographic and slope aspect variation as they affect snowpack, soil depth, and drainage. The ABLA/VAMY is generally found on cooler sites with greater snow pack and shallower, less drained soils. At lower elevations that are cool and wet, cool air drainage is a significant factor and the ABLA/RUPA HT, or the PIPU/EREX HT may be found. On lower elevation, warm sites forests of the *Abies concolor* or *Pseudotsuga menziesii* series may occur adjacent to this HT.

Comment—The ABLA/EREX HT is widespread in the Southwest and has been previously described by Alexander et al. (1987), DeVelice et al. (1986), Fitzhugh et al. (1987), and Moir and Ludwig (1979).

The more luxuriant and open undergrowth of the ABLA/EREX HT, in comparison to the other types of the *Abies lasiocarpa* and *Picea engelmannii* series, provides relatively good wildlife habitat. The timber productivity is moderate to high and may be enhanced by the presence of *Pseudotsuga menziesii* as a major seral species. Clearcuts will favor *Populus tremuloides;* selection cutting will favor *Abies lasiocarpa*

and *Picea engelmannii*. There may be a high risk of blowdown with shelterwood cutting. Warmer temperatures and localized surface fires probably play a role in maintaining *Pseudotsuga menziesii* as a major seral species at lower elevations, but fire frequency in this relatively moist habitat type is probably low. Severe fires may favor long-term *Populus tremuloides* successional communities. The high precipitation and relatively deep snowpack adds to the overall watershed value of this habitat type.

Abies lasiocarpa/Jamesia americana Habitat Type (ABLA/JAAM HT; subalpine fir/cliffbush)

Geographic location—This minor habitat type is limited to the highest elevations of the Santa Catalina Mountains of the Basin Ranges.

Vegetation—The climax dominant is *Abies lasiocarpa*, and *Picea engelmannii* is absent. *Pseudotsuga menziesii* and *Populus tremuloides* are major seral species with *Abies concolor* as a possible minor seral species. The undergrowth is characteristically shrubby and is dominated by *Jamesia americana, Ribes pinetorum, Rubus idaeus, Sambucus melanocarpa*, and *Symphoricarpos oreophilus* (fig. 3). Herbs can be well-represented, but distribution is patchy and their diversity is relatively low. Common forbs include *Pteridium aquilinum, Ramischia secunda, Vicia americana*, and *Viola canadensis*.

Physical setting—The cold, mesic ABLA/JAAM HT ranges from 8,750 to 9,100 feet (2,670 to 2,775 m) in elevation, and is usually found on steep, north-facing slopes with a deep snowpack.

Adjacent habitat types—The ABCO/BERE or PSME/Sparse HTs can occur on adjacent, slightly drier, but still cool sites; the ABCO/ACGL HT on wetter sites, and the ABCO/CAFO HT on drier, warmer sites.

Comments—The ABLA/JAAM HT is a very rare, localized type at the extreme southwestern edge of the distribution of *Abies lasiocarpa*. Niering and Lowe (1984) have also described this community, which essentially is represented by a few relic stands on top of Mt. Lemmon.

Figure 3.—*Abies lasiocarpa/Jamesia americana* HT on stabilized scree in the Santa Catalina Mountains at 8,800 feet (2,680 m). The high cover and richness of shrubs species is diagnostic.

Picea pungens series

This series is considered a mid elevation, topoedaphic climax that occupies lower slopes and canyon bottoms where there is significant cold air drainage (Layser and Schubert 1979). *Picea engelmannii*, although normally found at higher elevations, is commonly present in habitat types of this series. The higher density of both regeneration and mature *Picea pungens*, however, is diagnostic of this series. *Abies concolor*, and *Pseudotsuga menziesii* also can be co-climax species; *Pinus ponderosa*, *Pinus strobiformis*, and *Populus tremuloides* are considered seral. The *Picea pungens* series is one of several that comprise what is generally termed a mixed conifer forest because of the diverse mixture of overstory species that can occur.

Picea pungens/Juniperus communis Habitat Type (PIPU/JUCO HT; blue spruce/common juniper)

Geographic location—This minor habitat type is rare south of the Mogollon Rim and occurs locally only in the White Mountains of the Plateau Region.

Vegetation—*Picea pungens* and *Pseudotsuga menziesii* are climax codominants with occasional *Abies concolor* reproduction. *Picea engelmannii* is also possible as a minor climax species. *Pinus strobiformis* is a subclimax or major seral species. The undergrowth is characterized by the dominant and abundant *Juniperus communis*, and a scattering of other shrubs The herb layer is minor, although *Lathyrus arizonica* can be well-represented.

Physical setting—The cold, mesic PIPU/JUCO HT occupies mid to upper slope positions with northerly aspects, at about 8,500 feet (2,590 m).

Adjacent habitat types—The PIPU/EREX HT can be found immediately down slope in warmer, more mesic sites. On more xeric sites, this HT can intergrade to other mixed conifer HTs of the *Abies concolor* and *Pseudotsuga menziesii* series.

Comments—The extreme southwestern extension of this habitat type is in the White Mountains. The PIPU/JUCO HT is synonymous with the *Picea pungens -Pseudotsuga menziesii* HT, *Juniperus communis* Phase of Moir and Ludwig (1979). Fitzhugh et al. (1987) subsumed this type within the PIPU/EREX and PIPU/CAFO HTs. The PIPU/JUCO HT described by Youngblood and Mauk (1985) for southern Utah is similar, but contains several species which are not present here (e.g., *Arctostaphylos uva-ursi*, *Berberis repens*, and *Juniperus scopulorum*).

Picea pungens/Erigeron eximius Habitat Type (PIPU/EREX HT; blue spruce/forest fleabane)

Geographic location—This minor habitat is occasional in the White Mountains of the Plateau Region.

Vegetation—*Picea pungens* and *Pseudotsuga menziesii* are climax codominants. *Picea engelmannii* can be present as young and advanced regeneration, and is thus considered a minor climax species. The major seral tree is *Populus tremuloides*, with *Pinus strobiformis* and *P. ponderosa* as minor seral species. The undergrowth is characteristically herbaceous, but the shrub layer can be well-represented by *Rubus parviflorus* and *Pachystima myrsinities*. The herb layer is rich and diverse with *Erigeron eximius* and *Carex foenea* well-represented. Other common species are *Bromus richardsonii*, *Fragaria bracteata*, *Fragaria ovalis*, *Geranium richardsonii*, *Lathyrus arizonica*, *Pseudocymopteris montanus*, *Senecio wootonii*, *Valeriana* spp., and *Viola canadensis*. *Festuca arizonica* is absent or scarce.

Physical setting—This cool, moist mesic habitat type is found on northerly, lower colluvial slopes along drainages. Elevations range from 8,000 to 8,500 feet (2,440 to 2,590 m). Soils can be fluventic but not aquic, with umbric or mollic epipedons. They are at the cold margin of the frigid soil temperature regime.

Adjacent habitat types—The PIPU/EREX HT can intergrade Up slope to the PIPU/JUCO HT, and down slope to the *Picea pungens/Poa pratensis* HT (Fitzhugh et al. 1987) or *Poa pratensis* meadows. On warmer, drier slopes the *Picea pungens/Carex foenea* HT (Fitzhugh et al. 1987), PIPU/FEAR HT, or *Festuca arizonica* meadows may be found.

Comments—This type is widespread in the Southwest and has been previously described in detail by Moir and Ludwig (1979) for New Mexico and Arizona, DeVelice et al. (1986) for northern New Mexico and southern Colorado, and Fitzhugh et al. (1987) for southwestern New Mexico. This type is closely related to the PIEN/EREX HT where *Picea engelmannii* is the major climax species and *P. pungens* is the minor climax or seral species. The type, as represented in the White Mountains, usually lacks the strong tall-shrub component found in other areas of the Southwest; *Quercus gambelii* and *Acer glabrum* are notably absent. Alexander et al. (1984a) describe a *Picea pungens/Fragaria ovalis* HT for the Sacramento Mountains in southern New Mexico, which is also closely related to the PIPU/EREX HT described here.

Site quality is moderate to good for both *Picea pungens* and *Pseudotsuga menziesii* as a result of the well-watered lower slopes and relatively deep soils

(Moir and Ludwig 1979). The limited geographical extent of this type limits its timber resource value. Forage value is low to moderate for livestock; however, the stands can provide important forage and cover for wildlife using adjacent meadows. The adjacent meadows or "parks" may also receive high recreational use. Since the PIPU/EREX HT is often located along water courses, water quality and fisheries resource protection issues may need careful consideration, despite its limited distribution.

Picea pungens/Festuca arizonica Habitat Type (PIPU/FEAR HT; blue spruce/Arizona fescue)

Geographic location—This habitat type is minor and found only in the White Mountains of the Plateau Region.

Vegetation—*Picea pungens* is the climax dominant with *P. engelmannii*, *Pseudotsuga menziesii* and *Abies concolor* as minor climax species. *Pinus ponderosa* is the major seral species; *Pinus strobiformis* and *Populus tremuloides* are minor seral species. The undergrowth is characteristically grassy and dominated by *Festuca arizonica* in association with *Bromus richardsonii*, *Carex foenea*, and *Muhlenbergia virescens*. Shrub and forb cover is insignificant; the most commonly represented species are *Erigeron formosissimus*, *Potentilla hippiana*, *Ribes cereum*, and *Ribes pinetorum*.

Physical setting—The cool, dry mesic PIPU/FEAR HT can be found on gentle to steep slopes of southwesterly aspect, at about 8,200 to 9,200 feet (2,500 to 2,800 m). It is often associated with frost pockets and lower slopes where cool air drainage is significant.

Adjacent habitat types—This can adjoin the more mesic PIPU/EREX or PIEN/EREX HTs. The *Picea pungens/Poa pratensis* and the *Picea pungens/Carex foenea* HTs, as described by Fitzhugh et al. (1987), may also be possible on more mesic sites. The PIPU/FEAR may border *Festuca arizonica* grasslands.

Comments—The extreme southwestern extension of the PIPU/FEAR HT is in the White Mountains of the Plateau Region. This habitat type is more prevalent to the north and east, and has been described in detail by Fitzhugh et al. (1987) for southwest New Mexico, by DeVelice et al. (1986) for northern New Mexico and southern Colorado, and by Komarkova et al. (1988) for the west-central Rockies.

The PIPU/FEAR HT is the driest and warmest habitat type in the *Picea pungens* series. Site productivity is low to moderate for all species, with *Pinus ponderosa* having the highest productivity. Selection cutting will favor *Picea pungens*, shelterwood favors *Pseudotsuga menziesii*, and clear cutting favors *Pinus ponderosa*. Regeneration can be hindered by grass competition. Fire has played a major role in maintaining an open canopy which tends to increase grass cover. Light fires will reduce undergrowth densities, thus promoting conifer regeneration. Without fire, this type can approach the PIPU/EREX HT on more mesic sites. Forage productivity is high in open areas and decreases significantly under closed canopies. Since this type often adjoins scenic meadows, recreation potential is high.

Abies concolor Series

The *Abies concolor* series is widespread at mid elevations in the study area. This mixed coniferous series can have any mixture of *Abies concolor* with *Pseudotsuga menziesii*, *Picea engelmannii*, *Picea pungens*, *Abies lasiocarpa*, *Pinus ponderosa*, and *Pinus strobiformis*, depending on the moisture/temperature relationships of the site and the stage of succession. The more successful reproduction of *Abies concolor* among the various conifer species is diagnostic of the series (Layser and Schubert 1979).

Abies concolor/Vaccinium myrtillus Habitat Type (ABCO/VAMY HT; white fir/Rocky Mountain whortleberry)

Geographic location—This minor habitat type is known from the Chediski area in the northwest corner of the Fort Apache Indian Reservation, along the base of the Mogollon Rim of the Central Highlands. It is potentially present in other drainages along the Mogollon Rim.

Vegetation—*Abies concolor* and *Pseudotsuga menziesii* are codominant, with *Pinus strobiformis* and *P. ponderosa* as minor climax and minor seral species, respectively. The dominant shrub in the undergrowth is *Vaccinium myrtillus*. Other shrubs include *Chimaphila menziesii*, *Pachystima myrsinities*, and *Rubus parviflorus*. The herb layer is poorly to moderately expressed, with *Fragaria ovalis*, *Geranium richardsonii*, and *Valeriana* spp. present.

Physical setting—This is one of the coldest habitat types in the *Abies concolor* series and is found on very steep north-facing mid slopes in ravines at about 6,500 feet (1,980 m).

Adjacent habitat types—The ABCO/VAMY HT grades down slope into the more moist ABCO/ACGR HT. On drier sites it adjoins the ABCO/QUGA HT.

Comments—This habitat type is more common in northern New Mexico and southern Colorado (DeVelice et al. 1986), and is an isolated outlier in the study area. It is closely related to the *Pseudotsuga menziesii/Pachystima myrsinities* HT of the central Rocky Mountains (Hoffman and Alexander 1980), and weakly related to the *Abies grandis/Vaccinium globulare* HT of the northern Rockies (Pfister et al. 1977, Steele et al. 1981).

Site productivity is low, and cutting will continue to favor *Abies concolor* under most circumstances. The steep topography discourages livestock grazing, but big game use may be heavy.

Abies concolor/Carex foenea Habitat Type (ABCO/CAFO HT; white fir/silvertop sedge)

Geographic location—This minor habitat type is found only at higher elevations of the Pinaleno and Santa Catalina Mountains of the Basin Ranges.

Vegetation—*Abies concolor* and *Pseudotsuga menziesii* are codominant, with occasional reproduction of *A. lasiocarpa*. *Pinus strobiformis* and *P. ponderosa* are minor seral species. Shrubs are generally poorly represented, but *Acer glabrum* can be common. *Carex foenea* is the overwhelmingly dominant herb in association with *Bromus richardsonii* and *Poa pratensis*. The most constant forbs include *Campanula rotundifolia, Fragaria ovalis, Helenium hoopesii, Lathyrus arizonica, Pteridium aquilinum, Pseudocymopterus montanus*, and *Senecio wootonii*.

Physical setting—The cold, mesic ABCO/CAFO HT is found along upper slopes near summits of mountains at 9,000 to 10,200 feet (2,740 to 3,110 m). With high graminoid cover, dense sods of matted roots and rhizomes can develop.

Adjacent habitat types—On more moist sites, this HT grades to the ABCO/ACGL HT; on cooler, rockier sites, it grades to the ABLA/JAAM HT.

Comments—The ABCO/CAFO HT has been previously described for the Pinaleno Mountains (Moir and Ludwig 1979). The presence of *Abies lasiocarpa* as a minor climax species, usually in the seedling or sapling stage, indicates that this is perhaps a marginal *Abies lasiocarpa* habitat type at the edge of *Abies lasiocarpa*'s distribution.

Site quality for *Pseudotsuga menziesii* and *Abies concolor* is good, but the effect of graminoid competition on conifer reproduction may be severe following clearing. Grazing potential for livestock and wildlife is high.

Abies concolor/Berberis repens Habitat Type. (ABCO/BERE HT; white fir/Oregon grape)

Geographic location—This major habitat type occurs sporadically in the Santa Catalina, Chiricahua, Pinaleno, and Pinal Mountains of the Basin Ranges, and in the Bradshaw Mountains and along the Mogollon Rim of the Central Highlands.

Vegetation—*Abies concolor* and *Pseudotsuga menziesii* are the climax overstory dominants. *Pinus strobiformis* and *P. ponderosa* are minor seral trees. The undergrowth is usually very sparse with cover seldom exceeding 1%. Occasionally, shrubs such as *Symphoricarpos oreophilus, Berberis repens*, and *Holodiscus dumosus* are common. Herb cover is limited and characterized by small patches of grasses and scattered forbs. The most constant graminoids are *Bromus richardsonii, Carex geophila, Carex rossii*, and *Poa fendleriana*. Common forbs are *Lathyrus arizonica, Malaxis soulei, Senecio wootonii, Pteridium aquilinum, Smilacina* spp., *Thalictrum fendleri*, and *Viola canadensis*.

Physical setting—This is a cool, mesic to dry mesic HT which occurs on canyon side slopes and ridges of any aspect. Elevations range from 8,000 to 9,200 feet (2,440 to 2,800 m). Slopes vary from gentle to very steep.

Adjacent habitat types—The ABCO/BERE HT adjoins the ABCO/ACGL, PIEN/ACGL, or the ABCO/CAFO HTs on wetter, cooler sites; and the ABCO/QUGA or PIPO QUGA HTs under warmer, drier conditions.

Comments—The ABCO/BERE HT has been described in detail in the Southwest where it is referred to as the ABCO/Sparse HT (Alexander et al. 1984a, DeVelice et al. 1986, Fitzhugh et al. 1987, Moir and Ludwig 1979). Youngblood and Mauk (1985) originally described the ABCO/BERE HT in Utah. Their composition differs somewhat, but the physiognomic concept of a somewhat shrubby, but still sparse habitat type is the same. We have chosen the designation of Youngblood and Mauk (1985) rather than the ambiguous ABCO/Sparse name. The xeric *Pseudotsuga menziesii* forests reported by Peet (1981) for northern Colorado, and the *Pseudotsuga menziesii/Arnica cordifolia* HT described by Pfister et al. (1977) and Steele et al. (1981) are also related to the ABCO/BERE HT.

Site quality is moderate for *Pseudotsuga menziesii* and *Pinus ponderosa*. Clearcuts and seedtree cuts favor *P. menziesii* and *P. ponderosa*; shelterwood and selection cuts favor *Abies concolor*. Forage potential is low; in most cases, herb growth is limited by sea-

sonal soil-water deficits and shading (Moir and Ludwig 1979). Other inherently more productive habitat types may exhibit the appearance of an ABCO/BERE HT because of intense or prolonged wildlife browsing and livestock grazing.

Abies concolor/*Acer glabrum* Habitat Type (ABCO/ACGL HT; white fir/Rocky Mountain maple)

Geographic location—This major habitat type is found at the higher elevations of the Santa Catalina, Pinaleno, and Chiricahua Mountains of the Basin Ranges. It is potentially present in the Central Highlands and Plateau Region.

Vegetation—*Abies concolor* and *Pseudotsuga menziesii* are climax codominants. *Populus tremuloides* and *Pinus strobiformis* are major and minor seral trees, respectively. *Acer glabrum* forms a distinct subcanopy stratum in mature stands, and is the dominant tall shrub in late successional stages. Other well-represented shrubs may include *Holodiscus dumosa, Jamesia americana, Salix scouleriana, Sambucus melanocarpa,* and *Symphoricarpos oreophilus.* Herbs are also well-represented and include *Bromus richardsonii, Carex foenea, Erigeron eximius, Fragaria americana, Geranium richardsonii, Oxalis metcalfei, Thalictrum fendleri,* and *Viola canadensis.*

Physical setting—The cool to cold, moist mesic ABCO/ACGL HT is found on a variety of aspects at the highest elevations (8,650 to 9,200 feet or 2,630 to 2,800 m), usually in mid slope ravines or upper slopes with mostly deep soils near the cold extreme of the frigid soil moisture regime.

Adjacent habitat types—On drier sites, this type adjoins the ABCO/CAFO, ABCO/BERE or ABCO/QUGA HTs. Typically, the ABCO/ACGL HT is positioned on lower slopes and in ravines; the ABCO/CAFO HT is found on convex ridge lines of moderate soil depth; the ABCO/BERE HT is found on mid slope shallow soils, and the ABCO/QUGA HT is found on very rocky sites. On colder sites, the ABLA/JAAM HT may be found. This variety in adjacent habitat types leads to complex landscape mosaic as a function of local topographic differences.

Comments—The ABCO/ACGL HT represents one of the most widespread habitat types found in mixed conifer forests, but it is relatively uncommon south of the Mogollon Rim. This type has been described previously from many forests in Arizona, New Mexico, and Southern Colorado (Alexander et al. 1984a, 1987; DeVelice et al. 1986; Fitzhugh et al. 1987; Moir and Ludwig 1979). It has also been described for southern Utah by Youngblood and Mauk (1985). It is related to the *Pseudotsuga menziesii/Pachystima myrsinites* HT of central and northern Colorado (Hess and Wasser 1982, Hoffman and Alexander 1980). Weakly related types are represented by the foothill ravine forest community of Rocky Mountain National Park, Colorado (Peet 1981), and the *Abies grandis/Acer glabrum* HT of central Idaho (Steele et al. 1981).

Because of the cool, moist conditions characteristic of this habitat type, fires are generally of low intensity, erratic, and infrequent (Moir and Ludwig 1979). Such fire behavior has resulted in a diversity of stand structures within the type.

Timber productivity is low to moderate. Clearcuts and seedtree cuts will favor *Pseudotsuga menziesii,* which should regenerate well except when competition from shrubs is severe. The reduction in regeneration may be particularly significant when shrub growth increases following canopy removal. Selection cutting will favor *Abies concolor.* Old-growth stands produce little forage for livestock and, furthermore, the typically steep slopes impede access. However, shrubs provide abundant browse and cover for big game. Multistoried shrub layers increase microhabitat diversity for birds (Fitzhugh et al. 1987). In very old climax stands, the shrub component is reduced because of shading, and a moderate herbaceous cover becomes diagnostic.

Abies concolor/Erigeron eximius Habitat Type (ABCO/EREX HT; white fir/forest fleabane)

Valeriana arizonica phase (ABCO/EREX HT, VAAR PH; Arizona valerian)

Geographic location—This is a minor habitat type in the study area represented by the *Valeriana arizonica* Phase along the base of the Mogollon Rim in the northeast Central Highlands. It may occur in the Plateau Region as well.

Vegetation—*Abies concolor* and *Pseudotsuga menziesii* are climax codominants with *Pinus strobiformis* as a late seral or subclimax species. *Pinus ponderosa* and *Quercus gambelii* are minor seral species in early succession. The undergrowth is richly herbaceous with a variable representation of shrubs. *Acer glabrum, Holodiscus dumosus, Quercus gambelii,* and *Symphoricarpos oreophilus* may be present, but they seldom exceed 1% cover individually, or 5% collectively. Herb cover can exceed 40% and is dominated by *Bromus richardsonii, Fragaria ovalis, Geranium*

richardsonii, Valeriana arizonica, and *Viola canadensis.* It is the luxuriant, highly diverse undergrowth of this type that is characteristic. In this phase, *Valeriana arizonica* is well-represented and diagnostic, and *Erigeron eximius* may or may not be present.

Physical setting—The cool, moist mesic ABCO/EREX HT is located along the lower slopes of ravines with northerly aspects at about 7,000 feet (2,130 m). Soils are usually deep and well-watered throughout the growing season.

Adjacent habitat types—On rocky sites with shallower soils, the drier ABCO/QUGA or the wetter ABCO/ACGL HTs may be found. Along stream channels, the ABCO/JUMA HT may be adjoining.

Comments—The typic phase of the ABCO/EREX HT has been previously described in detail for New Mexico and southern Colorado by Fitzhugh et al. (1987), DeVelice et al. (1986) and Moir and Ludwig (1979). The VAAR PH is unique to the Central Highlands, and differs from the typic phase because *Erigeron eximius* is scarce or absent. The remainder of the species complement is very similar to that described in the above studies, except for the high cover of *Valeriana arizonica.*

Timber productivity for *Pseudotsuga menziesii* is moderate and favored by clearcuts and, to a lesser degree, by shelterwood cuts. Selection cutting will favor *Abies concolor.* The diversity and high cover of forbs, along with the close proximity of water, makes the ABCO/EREX HT excellent wildlife habitat.

Abies concolor/Quercus gambelii Habitat Type (ABCO/QUGA HT; white fir/Gambel oak)

Geographic location—This major habitat type is widespread and commonly occurs in the Santa Catalina, Pinaleno, Chiricahua, and Pinal Mountains of the Basin Ranges. In the Central Highlands, it occurs in the Sierra Ancha, Bradshaw Mountains, and along the Mogollon Rim. It is uncommon in the White Mountains of the Plateau Region.

Vegetation—*Abies concolor* and *Pseudotsuga menziesii* codominate in the overstory. *Pinus strobiformis, Pinus ponderosa,* and occasionally *Juniperus deppeana* are important seral species. *Quercus gambelii* is the characteristic subcanopy and undergrowth species, often forming nearly impenetrable thickets, especially following overstory thinning or fire. *Robinia neomexicana* and *Symphoricarpos* spp. are other common shrubs along with *Berberis repens* and *Lonicera arizonica.* Prominent graminoid cover includes *Bromus richardsonii, Carex foenea, Koeleria pyramidata,* and *Panicum bulbosum.* Forb species are well-represented and diverse, with over 50 species found in the HT. The most constant species are *Geranium richardsonii, Goodyera oblongifolia, Lathyrus arizonica, Pseudocymopterus montanus, Smilacina racemosa, Solidago sparsiflora, Thalictrum fendleri, Thermopsis divaricata,* and *Viola canadensis.*

Physical setting—The cool ABCO/QUGA HT is commonly found in mesic to dry mesic conditions. It has a wide elevation range of 6,000 to 8,100 feet (1,830 to 2,470 m) and can occur on almost all landscape positions and aspects. Slopes vary from gentle to very steep. Soils from this type have been identified by the Apache-Sitgreaves Terrestrial Ecosystem Survey as Eutric Glossoboralfs and Typic Paleoboralfs with a variety of textural classes (Laing et al. 1989).

Adjacent habitat types—This habitat type often adjoins *Pseudotsuga menziesii* or *Pinus ponderosa* forests which lack an *Abies* component. Wetter or cooler sites merge to the ABCO/ACGL HT. On more moist, down slope sites, this HT can adjoin the ABCO/ACGR HT. Drier or warmer sites may have types with grassy undergrowth, such as the PSME/MUVI or the PIPO/MUVI HTs.

Comments—The ABCO/QUGA HT is widespread in the Southwest and previously has been described in Arizona, New Mexico, and southern Colorado (Alexander et al. 1984a, 1987; DeVelice et al. 1986; Fitzhugh et al. 1987; Moir and Ludwig 1979). The ABCO/QUGA HT is also a minor habitat type in southern Utah (Youngblood and Mauk 1985).

Fire is a major factor in the ecology of these forests and the high *Quercus gambelii* cover is probably related to its ability to reproduce vegetatively after fire. If frequent fires maintain a high conifer mortality rate, persistent *Quercus gambelii* scrub communities may result (Brown 1958).

Timber productivity is moderate for both *Pseudotsuga menziesii* and *Pinus ponderosa.* Oaks will tend to occupy sites following exposure resulting from clearcuts and seedtree cuts; shelterwood and selection cutting will, in contrast, favor conifers. This habitat type provides valuable cover and food for deer and bird populations.

Abies concolor/Acer grandidentatum Habitat Type (ABCO/ACGR HT; white fir/bigtooth maple)

Geographic location—This major habitat type occurs sporadically in the Santa Catalina, Pinaleno, and

Pinal Mountains of the Basin Ranges; in the Sierra Ancha, Bradshaw Mountains, and along the Mogollon Rim of the Central Highlands.

Vegetation—Over stories exhibit codominance of *Abies concolor* and *Pseudotsuga menziesii*; *Pinus strobiformis* is a minor climax or late seral associate. *Pinus ponderosa* is a minor, early seral species. In addition to abundant *Acer grandidentatum*, *Juglans major* and *Quercus gambelii* are common broadleaf tree associates. Herbaceous undergrowth is well-represented but variable in expression. *Bromus richardsonii*, *Carex foenea*, and *Koeleria pyramidata* are the common graminoids. *Fragaria ovalis*, *Galium asperrimum*, *Geranium richardsonii*, *Thalictrum fendleri*, and *Viola canadensis* are among the most constant forbs.

Physical setting—The cool, moist mesic ABCO/ACGR HT generally occurs along steep northerly, lower slopes of drainages at elevations ranging from 6,700 to 7,600 feet (2,050 to 2,310 m).

Adjacent habitat types—Typically, the ABCO/QUGA HT adjoins this HT upslope. Riparian communities may be found downslope along drainages.

Comments—The ABCO/ACGR HT type has been previously described for Arizona and central and southwestern New Mexico (Alexander et al. 1984a, Fitzhugh et al. 1987, Moir and Ludwig 1979). Whittaker and Niering (1965) described a *Acer grandidentatum* ravine forests in the Santa Catalina Mountains that most likely are this ABCO/ACGR HT.

The mesic conditions and typically deep soils in this habitat type favor rapid tree growth. However, the restricted area of the type reduces the potential for extensive timber management operations. Diverse wildlife habitat exists because of the varied vegetation layers and the close proximity to water.

Abies concolor/Juglans major Habitat Type (ABCO/JUMA HT; white fir/Arizona walnut)

Geographic location—This is minor, broadly defined, riparian habitat type is found in higher elevation drainages along the Mogollon Rim and in the Sierra Ancha of the Central Highlands.

Vegetation—The overstory is characterized by the dominance of *Abies concolor*, with *Pseudotsuga menziesii* as a minor climax associate. There is a diverse subcanopy composed of a mixture of *Acer negundo*, *Fraxinus pennsylvanica*, *Juglans major*, or *Quercus gambelii*. *Pinus ponderosa* is a minor seral species. The shrub layer is minor; *Berberis repens* is the most common shrub species present. The herb stratum is luxuriant with *Fragaria ovalis*, *Galium asperrimum*, *Geranium richardsonii*, *Lathyrus arizonica*, *Osmorhiza depauperata*, *Thalictrum fendleri*, and *Viola canadensis* present and usually common.

Physical setting—The cool, moist mesic ABCO/JUMA HT is located along terraces of high-elevation perennial streams (8,000+ feet; 2,440+ m). Soils are usually alluvial Aquents and tend to be silty in a matrix of boulders and rocks.

Adjacent habitat types—Up slope from this HT nonriparian HTs of the *Abies concolor* or *Pseudotsuga menziesii* series are usually found.

Comments—The ABCO/JUMA HT has been previously described in southern New Mexico by Alexander et al. (1984a) and Fitzhugh et al. (1987). Documentation is limited and additional work is needed to better define this type.

Although the ABCO/JUMA HT is limited geographically, its presence along stream courses makes it important in water, fisheries, and wildlife resource management.

Pseudotsuga menziesii Series

This series is characterized by stands dominated by *Pseudotsuga menziesii*, from reproduction to mature size classes. *Pinus strobiformis* and *P. ponderosa* can either be subclimax codominants or major seral species. *Abies* spp. and *Picea* spp. are absent or accidental. The distribution of the series is limited to the moisture/temperature gradient between the *Abies concolor* and *Pinus ponderosa* series, and this series generally lies between the two in elevation.

Pseudotsuga menziesii/Sparse Habitat Type (PSME/Sparse HT; Douglas-fir/Sparse)

Geographic location—This minor habitat type is known from the Santa Catalina and Santa Rita Mountains of the Basin Ranges, and it likely occurs in the Central Highlands. It is common in the Plateau Region outside the study area.

Vegetation—The PSME/Sparse HT is characterized by the strong presence of *Pseudotsuga menziesii* in all size classes. *Pinus strobiformis* is a minor climax associate. *Abies concolor* can be a minor coclimax species but is usually absent or poorly represented. The undergrowth is low in diversity and sparse; total cover seldom exceeds 5% (fig. 4). *Symphoricarpos oreophilus* is the most constant shrub, occurring as isolated individuals. Graminoids are the conspicuous herbs (*Bromus richardsonii*, *Carex foenea*, *C.*

Figure 4.—*Pseudotsuga menziesii*/Sparse HT in a mid slope position in the Santa Catalina Mountains at 8,650 feet (2,620 m). The herb and shrub layers are almost absent.

geophila, and *Poa fendleriana*) along with soil mosses. Forbs are minor or scattered and may include *Malaxis soulei*, *Pseudocymopterus montanus*, *Senecio wootonii*, *Smilacina stellata*, and *Thalictrum fendleri*.

Physical setting—The cool, mesic PSME/Sparse HT occurs on upper slopes and ridges at mid and upper elevations (8,500+ feet; 2,600 m). Soils tend to be rocky and shallow.

Adjacent habitat types—Adjoining habitat types on more mesic sites are the ABCO/CAFO, ABCO/ACGL, or ABCO/ACGR HTs. More xeric sites feature ABCO/QUGA, PSME/QUGA, PSME/MUVI, or PSME/QURU HTs.

Comments—The PSME/Sparse HT has been reported in northern Arizona by Alexander et al. (1984b), who indicated that this habitat type is often difficult to identify because of the lack of diagnostic species. They also suggested that the PSME/Sparse is intermediate between shrub-dominated and grass-dominated communities—a case where neither component is well-expressed. Further, young successional communities of other habitat types may resemble this type where dense pole stands of *Pseudotsuga menziesii* dominate and shade out the understory species. The sparse character and overall physiognomy of this type are similar to the ABCO/BERE, ABLA/Moss, and PIEN/Moss HTs.

Pseudotsuga menziesii productivity is moderate, and this species is favored under most timber-harvest methods. The dense overstory canopy is partly responsible for the sparse undergrowth. With canopy removal, shrubs and grasses will show a moderate response to release. In the climax condition, forage and cover are poor.

Pseudotsuga menziesii/*Muhlenbergia virescens* Habitat Type (PSME/MUVI HT; Douglas-fir/screwleaf muhly)

Geographic location—This major habitat type is widespread in the Chiricahua, Pinaleno and Santa Catalina Mountains of the Basin Ranges, and it is occasionally found to the north in the White Mountains of the Plateau Region.

Vegetation—*Pseudotsuga menziesii* and *Pinus ponderosa* are generally present in all size classes, while *Pinus strobiformis* is a minor climax species, usually present only in small size classes. *Abies concolor* is absent or minor. The type is characterized by a luxurious grassy undergrowth dominated by *Muhlenbergia virescens* (fig. 5). Shrub cover is not significant. Common herbs are *Antennaria* spp., *Bromus richardsonii*, *Carex geophila*, *Koeleria pyramidata*, *Eupatorium herbaceum*, *Pseudocymopterus montanus*, *Senecio wootonii*, and *Solidago sparsiflora*.

Physical setting—The cool, mesic PSME/MUVI HT occurs on dry mid to upper slopes on ridges at elevations between 8,000 and 9,300 feet (2,440 and 2,840 m). All aspects are encountered, and slopes vary from moderate to steep. Under conditions where soils have dominated for an extended period, soils with mollic epipedons such as Mollic Eutroboralfs may develop. Where trees have a greater influence, the epipedon is often ochric (e.g., Typic Eutroboralfs).

Adjacent habitat types—On cool, rockier sites the PSME/QUGA or ABCO/QUGA HTs are adjoining.

Figure 5.—*Pseudotsuga menziesii/Muhlenbergia virescens* HT found throughout the study area, usually on upper slopes. The understory is characteristically grassy and shrubs are insignificant.

On warmer, rockier sites, the PIPO/QUGA HT is found. The PIPO/MUVI HT may be found on warmer sites with fine-textured soils.

Comments—The PSME/MUVI HT was first described in Arizona by Moir and Ludwig (1979) and reported in southwestern New Mexico by Fitzhugh et al. (1987). In the Santa Catalina Mountains, Whittaker and Niering (1965) also described a similar community.

The high cover of *Muhlenbergia virescens* and assorted herbs suggests frequent fires within the type. Areas lacking recent fires have abundant coniferous regeneration and depauperate herb layers.

Site quality is moderate to high for *Pseudotsuga menziesii* and *Pinus ponderosa*. Clearcuts and seedtree cuts will favor increased graminoid cover at the expense of conifer regeneration. Shelterwood cutting will favor *Pinus ponderosa*. Selection cutting will tend to favor *Pseudotsuga menziesii* because of its somewhat greater shade tolerance. Grazing potential may be high within this type, but access is often difficult, and water sources are usually not readily available.

Pseudotsuga menziesii/Muhlenbergia montana Habitat Type (PSME/MUMO HT; Douglas-fir/mountain muhly)

Geographic location—This minor habitat type is found in the Santa Catalina Mountains of the Basin Ranges.

Vegetation—*Pseudotsuga menziesii* is the climax overstory dominant. *Abies concolor* is absent or accidental. *Pinus strobiformis* and *Populus tremuloides* are minor seral species. *Muhlenbergia montana* dominates the undergrowth along with *Blepharoneuron tricholepis* and *Poa fendleriana*.

Physical setting—The cool, dry mesic PSME/MUMO HT occupies high-elevation ridgetops (8,850 feet or 2,700 m) near the summit of Mt. Lemmon. As in the PSME/MUVI, soils of this HT can develop mollic epipedons where grass cover is luxuriant, or ochric epipedons where trees suppress grass cover. But soils here tend to be from lithic subgroups and are rockier.

Adjacent habitat types—Adjacent HTs are the ABLA/JAAM HT on northerly aspects and the PSME/QUGA HT on southerly exposures.

Comments—This type has been previously described by Fitzhugh et al. (1987) for southwestern New Mexico, and by Alexander et al. (1987) for the Zuni Mountains. In this study, this HT was found at higher elevations and lacked several of the species reported by the above authors. In the Santa Catalina Mountains, this type may be a topo-edaphic anomaly where *Pseudotsuga menziesii* and *Muhlenbergia montana* have become dominant on a cold ridge top with extremely lithic soils.

Pseudotsuga menziesii/Quercus gambelii Habitat Type (PSME/QUGA HT; Douglas-fir/Gambel oak)

Geographic location—This major habitat type commonly occurs in the Santa Catalina, Santa Rita, Huachuca, Pinaleno, Chiricahua and Galiuro Mountains of the Basin Ranges, and in the White Mountains and on the northern Nantanes Plateau of the Plateau Region. It also occurs in the Pinal Mountains and potentially elsewhere in the Central Highlands.

Vegetation—*Pseudotsuga menziesii* is the climax dominant in the overstory. *Pinus ponderosa* and *P. strobiformis* are major seral species and can persist into late seral/subclimax stages. *Juniperus deppeana* may sometimes occur as a minor seral species. *Quercus gambelii* is well-represented to abundant, and dominates the shrub layer in association with such species as *Holodiscus dumosa, Robinia neomexicana* and *Symphoricarpos oreophilus*. Herb layers tend to be grassy with a diverse but variable mixture of forbs (96 grass and forb species have been recorded for this HT). *Bromus richardsonii, B. porteri, Koeleria pyramidata, Poa fendleriana,* and *Stipa pringlei* are the most common grasses. The most constant forbs are *Achillea millefolium, Galium asperrimum, G. fendleri, Lathyrus arizonica, Oxalis metcalfei, Pseudocymopterus montanus, Senecio neomexicanus, Thalictrum fendleri,* and *Vicia americana.*

Physical setting—In this cool, mesic habitat type of northerly aspects, slopes range from moderate to very steep, and elevations range from 6,300 to 7,600 feet (1,920 to 2,310 m). Soils are commonly fine-textured and are skeletal inceptisols or alfisols.

Adjacent habitat types—The PSME/QUGA HT occupies a position in the environmental gradient between the cooler ABCO/QUGA HT and the warmer PIPO/QUGA or PSME/QURU HTs. Adjacent areas with finer textured soils may support PSME/MUVI or PIPO/MUVI HTs.

Comments—Alexander et al. (1984a,b) and Fitzhugh et al. (1987) report a typic phase of the PSME/QUGA HT for southern New Mexico and northern Arizona that is equivalent to the HT described here. Alexander et al. (1987) and Youngblood and Mauk (1985) also describe the PSME/QUGA HT for central New Mexico and southern Utah, respectively, with a shrub and forb composition that is somewhat different than that of the HT reported here. This dissimilarity increases further north with the PSME/QUGA HT as described by DeVelice et al. (1986) in southern Colorado. The *Pinus ponderosa/Quercus gambelii/ Carex geyeri* habitat type described by Hess and Wasser (1982) in the central Rockies and the *Pseudotsuga menziesii/Symphoricarpos oreophilus* habitat type from the central and northern Rockies (Komarkova et al. 1988, Pfister et al. 1977 Steele et al. 1981) show only weak affinities with the PIPO/QUGA HT.

As in the other *Quercus* habitat types, oak is the most conspicuous feature of the vegetation. Grasses are commonly important in the undergrowth; therefore this type has broad management possibilities that range from timber to forage production (DeVelice et al. 1986). Vertical diversity in this shrubby type supports varied bird species (Fitzhugh et al. 1987).

Timber productivity for *Pseudotsuga menziesii* and *Pinus ponderosa* is moderate. Clearcuts and seedtree cuts will favor *Pinus ponderosa,* but the release of *Quercus gambelii* can hinder conifer reproduction. Selection cuts will tend to favor *Pseudotsuga menziesii.* Fire suppression favors dense stands of *Pseudotsuga* over the seral *Pinus ponderosa.* In contrast, severe fires may favor oak scrub dominated by *Q. gambelii.*

Pseudotsuga menziesii/Acer grandidentatum Habitat Type (PSME/ACGR HT; Douglas-fir/big tooth maple)

Geographic location—This minor habitat type is known only from the Galiuro Mountains, but may possibly occur in other mountains of the Basin Ranges.

Vegetation—*Pseudotsuga menziesii* is the climax dominant in the overstory, with a subcanopy of *Acer grandidentatum* and *Pinus discolor. Acer grandidentatum* also dominates the characteristically shrubby undergrowth (fig. 6). Other common shrubs include *Arbutus arizonica, Fraxinus pennsylvanica, Garrya wrightii, Holodiscus dumosus, Lonicera arizonica, Ptelea angustifolia, Prunus serotina, Quercus chrysolepis, Q. rugosa, Q. arizonica, Rhamnus betulaefolia, Robinia neomexicana, Rubus neomexicana,* and *Symphoricarpos oreophilus. Poa fendleriana* is well-represented in the herb layer, but the only other common forbs and grasses are

Figure 6.—*Pseudotsuga menziesii/Acer grandidentatum* HT in the Galiuro Mountains at 7,300 feet (2,225 m). The shrub cover is high and herbaceous cover low.

Bromus richardsonii, Brickellia grandiflora, and *Galium asperrimum.*

Physical setting—The cool to mild, moist mesic PSME/ACGR HT is found either in steep, upper slope draws at approximately 7,000 feet (2,135 m), or at lower elevations (5,000 to 5,300 feet or 1,530 to 1,620 m) as a topo-edaphic climax in canyon bottoms, where it is found on benches along stream channels.

Adjacent habitat types—Pine-oak woodlands are found on drier and warmer upper slopes. Along stream channels, the PSME/ACGR HT may adjoin riparian communities dominated by *Alnus oblongifolia, Fraxinus pennsylvanica, Acer negundo,* or *Acer grandidentatum.*

Comments—The PSME/ACGR HT is a rare and peripheral habitat type in the United States and is probably more common in northern Mexico.

Site productivity is low for *Pseudotsuga menziesii* and successful reproduction following harvest is unlikely. Cover and forage is good to excellent for wildlife, but the shrubbiness may impede livestock use.

Pseudotsuga menziesii/Quercus rugosa Habitat Type (PSME/QURU HT; Douglas-fir/netleaf oak)

Geographic location—This minor habitat type is found sporadically in the Pinaleno, Santa Catalina, Santa Rita, and Huachuca Mountains, and infrequently along the edge of the Nantanes Plateau of the Basin Ranges.

Vegetation—*Pseudotsuga menziesii* is the overstory climax dominant with *Pinus ponderosa* and *Pinus strobiformis* as major seral species. The evergreen oak, *Quercus rugosa,* is the characteristic shrub, often reaching a cover of 60% or more. *Quercus hypoleucoides* is common, but with a cover of less than 5%. On very rocky sites, *Quercus chrysolepis* can be well-represented. Grass cover is low and most commonly represented by *Bromus richardsonii, Koeleria pyramidata, Muhlenbergia longiligula,* and *Poa fendleriana.* Herbaceous cover is also minor, with a scattering of species such as *Galium tinctorium, Hedeoma hyssopifolium, Lathyrus graminifolius, Senecio neomexicanus, Thalictrum fendleri,* and *Vicia americana.*

Physical setting—The cool, dry mesic PSME/QURU HT ranges in elevation from 6,500 to 8,800 feet (1,980 to 2,680 m) on northerly aspects. Soils are shallow, very rocky, and are developed from rhyolite and granite parent materials. At high elevations the type occupies steep, mid and upper slopes with convex topography. The PSME/QURU HT can also occur as a topo-edaphic climax at lower elevations in ravines and canyons with significant cold air drainage. The soils in such locations are deeper yet remain cool.

Adjacent habitat types—On warmer sites at higher elevations, the PSME/QUHY, PIPO/QUHY, or PIPO/MUVI HTs and occasionally the PIPO/QUGA HT adjoin this HT. On cooler sites, the common ecotone is with the PSME/QUGA HT. In lower elevation canyons, the PIPO/JUMA HT or other riparian forests may be found.

Comments—The PSME/QURU is sporadic in occurrence and normally found as part of a mosaic of *Quercus hypoleucoides* and *Q. gambelii* types, which shifts in response to small changes in topography, soil rockiness, and aspect in the local landscape.

Timber productivity for conifers (compared to other types where oak is a component) is poor in the Up slope positions and moderate in the canyon sites. Seedtree cutting or clear cutting will favor oak scrub; shelterwood cutting will favor *Pseudotsuga* and *Pinus ponderosa*; and selection cutting will favor *Pseudotsuga menziesii*. Sustained oak fuelwood production potential is low. Grazing potential is low because of the steep, rocky slopes. Both forage and cover are provided by this HT, and it has moderate value as wildlife habitat.

Pseudotsuga menziesii/Quercus hypoleucoides Habitat Type (PSME/QUHY HT; Douglas-fir/silverleaf oak)

Geographic location—This major habitat type is found in the Chiricahua, Pinaleno and Santa Catalina Mountains, and occasionally along the rim of the Nantanes Plateau of the Basin Ranges. It may possibly occur in the Pinal Mountains but is absent elsewhere in the Central Highlands.

Vegetation—*Pseudotsuga menziesii* dominates the overstory with *Pinus ponderosa* as a major seral or, in some instances, a co-climax dominant. *Abies concolor* is absent or accidental. *Juniperus deppeana* is common as a subcanopy tree or shrub. Undergrowth is characterized by Madrean species, with *Quercus hypoleucoides* ranging from well-represented to abundant. *Quercus arizonica* and *Q. rugosa* are common to well-represented but are subordinate to *Q. hypoleucoides*. Other shrubs include *Ceanothus fendleri*, *Cercocarpus montanus*, and *Garrya wrightii*. The robust grass, *Muhlenbergia longiligula*, is well-represented and typically dominates the ground cover. *Bromus richardsonii*, *Carex geophila*, *Koeleria pyramidata*, and *Poa fendleriana* can also be present. Forbs are poorly represented; the most constant species are *Comandra umbellata*, *Eupatorium herbaceum*, *Oxybaphus comatus*, and *Senecio neomexicanus*.

Physical setting—The cool, dry mesic PSME/QUHY HT occurs at elevations ranging from 6,600 to 7,700 feet (2,010 to 2,350 m) on northerly to east-facing, mid to upper slopes.

Adjacent habitat types—Adjoining habitat types include the PSME/QUGA HT in more mesic and cooler settings; the PSME/QURU HT on cooler aspects or higher elevations; and the PSME/QUAR, PIPO/QUHY, or PIPO/QURU HTs on drier sites.

Comments—This type was broadly described by Moir and Ludwig (1979) for southeastern Arizona and southwestern New Mexico, and then by Fitzhugh et al. (1987) for southwestern New Mexico. Their definition of the PSME/QUHY HT would also include the PSME/QURU HT described above. In Arizona, the PSME/QUHY HT is more or less limited to the Basin Ranges Region. In the Central Highlands, the PSME/QUHY HT is replaced by the PSME/QUAR HT (except in the Pinal Mountains).

There is abundant cover for wildlife in this type, but forage (other than acorns) is limited for either wildlife or domestic stock. Coniferous timber production is typically low. Clearcuts and seedtree cuts favor *Quercus* spp.; selection cuts favor *Pseudotsuga menziesii*; and shelterwood cuts favor both *Pseudotsuga menziesii* and *Pinus ponderosa*. This HT has fuelwood potential from *Quercus* spp. and *Juniperus deppeana*.

Pseudotsuga menziesii/Quercus arizonica Habitat Type (PSME/QUAR; Douglas-fir/Arizona white oak)

Geographic location—This minor habitat type of the Central Highlands is found occasionally in the Bradshaw Mountains, the Sierra Ancha, and along the Mogollon Rim.

Vegetation—*Pseudotsuga menziesii* and *Pinus ponderosa* are climax codominants; *Abies concolor* is absent or accidental. *Juniperus deppeana* is a constant species but a minor climax component of the sub-

canopy. The shrub layer is dominated by *Quercus arizonica*, with *Q. gambelii* and *Q. emoryi* poorly represented; *Q. hypoleucoides* is absent. The herb layer is sparse and characterized by scattered bunch grasses, including *Koeleria pyramidata*, *Muhlenbergia longiligula*, and *Poa fendleriana* (fig. 7). The most constant forbs are *Comandra umbellata*, *Pseudocymopterus montanus*, and *Senecio neomexicana*.

Physical setting—The cool, dry mesic PSME/QUAR HT is found on a variety of land forms with southerly aspects at mid elevations (5,800 to 7,000 feet; 1,770 to 2,130 m). The sites tend to be rocky and have skeletal soils.

Adjacent habitat types—On cooler sites, the PSME/QUAR HT adjoins PSME/QUGA or PIPO/QUGA HTs. Warmer sites support the PIPO/QUAR HT or montane chaparral. This type is often found in a mosaic with the PIPO/QUAR HT occupying ridges and the PSME/QUAR HT in the drainages of the local landscape.

Comments—Wildlife forage and cover are moderate, but grazing for domestic livestock is poor. This type is at the warm limit of the ecological range of *Pseudotsuga menziesii*, and timber potential for that species is low. *Pinus ponderosa* productivity is poor to moderate. Timber harvest, in general, will favor oak scrub or montane chaparral; but in cases where moisture is adequate, timber production may be good for *Pinus ponderosa*, relative to other evergreen oak habitat types.

Pinus ponderosa Series

This series is generally found at lower elevations than spruce-fir or mixed conifer forests, and is dominated in all size classes by *Pinus ponderosa*. Environments tend to be too warm and dry for successful *Pseudotsuga menziesii* establishment and maintenance (Layser and Schubert 1979). *Pinus edulis* or *P. discolor*, along with *Juniperus* spp. and *Quercus* spp., are common subcanopy associates. The *Pinus ponderosa* series is the most prevalent of the forest series south of the Mogollon Rim and is highly diverse with respect to habitat types.

Figure 7.—*Pseudotsuga menziesii*/*Quercus arizonica* HT along an upper slope in the Bradshaw Mountains at 6,560 feet (2,000 m). *Q. arizonica* is both subcanopy and shrub dominant, with scattered bunch grasses beneath.

Pinus ponderosa/Festuca arizonica Habitat Type (PIPO/FEAR HT; ponderosa pine/Arizona fescue)

Geographic location—This habitat type is most commonly found in the Plateau Region, on the north side of the White Mountains; it is rarely found south of the Mogollon Rim.

Vegetation—The PIPO/FEAR HT is characterized by pure, open stands of *Pinus ponderosa* with a grassy undergrowth dominated by *Festuca arizonica*. *Muhlenbergia virescens* and *M. montana* are poorly represented and never dominant. Shrubs are absent or scarce. Forbs can include *Senecio wootonii*, *Pteridium aquilinum*, and *Potentilla hippiana*.

Physical setting—The cool, mesic PIPO/FEAR HT is found at mid elevations (8,000 feet; 2,044 m) on plateaus or on gentle slopes with southerly aspects. Soils commonly tend to be fine-textured alfisols, lacking a significant coarse fragment component. Where graminoids have dominated the site for an extended period of time, mollic epipedons may develop.

Adjacent habitat types—On cooler sites with coarser textured soils, adjacent habitat types may include the PIPO/QUGA HT, or PSME/QUGA HT (or other mixed conifer habitat types). Drier sites may feature the PIPO/MUVI and PIPO/BOGR HTs, or *Festuca arizonica* or *Bouteloua gracilis* grasslands.

Comments—This habitat type is widespread in the Southwest, north of the Mogollon Rim. It has been described in detail by Fitzhugh et al. (1987) for southwestern New Mexico, by DeVelice et al. (1986) for northern New Mexico and southern Colorado, by Alexander et al. (1987) for central New Mexico, by Hanks et al. (1983) for northern Arizona, and by Komarkova et al. (1988) for west central Colorado. The *Pinus ponderosa/Festuca idahoensis* habitat type described for the central and northern Rocky Mountains is similar in physiognomy (and to some degree in composition) to the PIPO/FEAR HT (Daubenmire and Daubenmire 1968, Hoffman and Alexander 1976, Mauk and Henderson 1984, Pfister et al. 1977, Steele et al. 1981).

The PIPO/FEAR HT is the coolest and wettest of the grass-dominated *Pinus ponderosa* habitat types. *Pinus ponderosa* site productivity is moderate to high. Shelterwood cutting is considered the best method for ensuring good reproduction of *Pinus ponderosa*. Fire has been important historically in maintaining the savanna-like appearance of this habitat type, with its grassy undergrowth lacking thickets of trees and shrubs. With fire suppression, the canopy tends to close and reduce grass cover. *Festuca arizonica* is sensitive to overgrazing and may be replaced by *Muhlenbergia virescens* or *Bouteloua gracilis*.

Pinus ponderosa/Muhlenbergia virescens Habitat Type (PIPO/MUVI HT; ponderosa pine/screwleaf muhly)

Geographic location—This major habitat type occurs extensively in the Chiricahua, Pinaleno, Galiuro, Pinal, Santa Terresa, Santa Catalina, Santa Rita and Huachuca Mountains of the Basin Ranges; in the Malay Gap area of the Nantanes Plateau and White Mountains of the Plateau Region; and at the foot of the Mogollon Rim of the Central Highlands.

Vegetation—*Pinus ponderosa* is the climax overstory species with *Juniperus deppeana* common in the subcanopy. The occasional occurrence of *Pinus strobiformis*, *Populus tremuloides*, and *Pseudotsuga menziesii* in small size classes suggests the mesic character of this habitat type. Undergrowth shrubs are generally scarce, although *Quercus gambelii* is common. The undergrowth is characteristically grassy and dominated by abundant *Muhlenbergia virescens*. Other graminoids that may be present and common include *Bromus richardsonii*, *Carex geophila*, *Koeleria pyramidata*, *Muhlenbergia longiligula*, *Poa fendleriana*, *Sitanion hystrix*, and *Stipa pringlei*. Forbs are diverse, with over 80 species possible, but their cover is relatively insignificant. The most constant are *Hieracium fendleri*, *Hedeoma hyssopifolium*, *Pseudocymopteris montanus*, *Pteridium aquilinum*, *Senecio neomexicanus*, *Solidago wrightii*, and *Solidago sparsiflora*.

Physical setting—The cool, mesic PIPO/MUVI HT occurs on lower to upper slopes at elevations ranging from 6,800 to 9,300 feet (2,070 to 2,840 m). Slopes tend to be moderately steep to steep, with northerly and/or easterly aspects. Soils sampled were all Udic Ustochrepts developed from a variety of parent materials.

Adjacent habitat types—This type is closely related to the PSME/MUVI HT and adjoins it or the PIPO/FEAR HT at higher elevations. The PIPO/QUGA or PSME/QUGA HTs occur at similar elevations but on more rocky, skeletal soils. At lower elevations in the Basin Ranges, this HT grades to the PIPO/QUHY or PIPO/QURU HTs; in the Central Highlands Region, it grades to the PIPO/QUAR HT; and in the Plateau Region, it grades to the PIPO/BOGR HT or grassland.

Comments—This common habitat type of the Southwest has been previously described in southwestern and central New Mexico by Alexander et al. (1987), and Fitzhugh et al. (1987), and in northern

Arizona by Hanks et al. (1983). South of the Mogollon Rim this type lacks *Pinus edulis*.

Fire is important in maintaining this habitat type since it occurs at the cool, moist end of the ecological range of the *Pinus ponderosa* series. Young *Pseudotsuga menziesii* trees are less fire resistant and more shade tolerant than *Pinus ponderosa* (Moir and Ludwig 1979) and, therefore, without periodic fire, *Pseudotsuga menziesii* would gain dominance in many stands. Furthermore, fire exclusion could result in increased densities of *Pinus ponderosa* and *Pseudotsuga menziesii* thereby resulting in decreased herb cover and diminished grazing. Livestock carrying capacity is typically high in the more open stands compared to most other *Pinus ponderosa* habitat types (Hanks et al. 1983).

The PIPO/MUVI HT is generally productive for *Pinus ponderosa* timber because of the mesic conditions, low competition with other woody plants, and characteristically deep soils. Establishment of seedlings following clearcuts or seedtree cuts may prove difficult because of the high grass cover. Fire may be required to create adequate seedbeds, but it may also favor *Quercus* scrub in the drier environments. Shelterwood cutting is probably the best method to ensure reproductive success.

Pinus ponderosa/Muhlenbergia montana Habitat Type (PIPO/MUMO HT; ponderosa pine/mountain muhly)

Geographic location—This minor habitat type is found in the Sierra Ancha Mountains of the Central Highlands Region, and in the Rincon Mountains of the Basin Ranges Region.

Vegetation—*Pinus ponderosa* is found in an open canopy with *Juniperus deppeana*, *Pinus edulis*, and/or *P. discolor* as associated subcanopy minor climax species. The undergrowth is characteristically grassy and dominated by *Muhlenbergia montana* (fig. 8). Other grasses and forbs include *Artemisia* spp., *Bouteloua gracilis*, *Carex geophila*, *Kuhnia rosmarinifolia*, *Lathyrus graminifolius*, *Senecio neomexicanus*, *Sitanion hystrix*, and *Stipa pringlei*.

Physical setting—The cool, mesic PIPO/MUMO HT is found on gentle to moderate slopes or plateaus

Figure 8.—*Pinus ponderosa/Muhlenbergia montana* HT at the summit of the Sierra Ancha at 7,480 feet (2,280 m). This predominantly grassy type is more common to the north. The floristic influence from southern Arizona and Mexico is indicated by the presence of *Agave* spp. in the foreground.

at elevations between 7,100 and 8,500 feet (2,160 and 2,590 m). Soils tend to be lithic and skeletal alfisols.

Adjacent habitat types—On less rocky sites or at higher elevations, this HT may adjoin the PIPO/FEAR. It may also grade to the shrubby PIPO/QUGA HT at similar elevations and to the PSME/QUGA HT at higher elevations. At lower elevations in the Basin Ranges and Central Highlands Regions, this HT may grade to the PIPO/QUHY or PIPO/QUAR HTs.

Comments—The PIPO/MUMO HT has been previously defined in the Southwest by Alexander et al. (1987), DeVelice et al. (1986), and Fitzhugh et al. (1987). The *Pinus ponderosa/Poa fendleriana* habitat type of northern Arizona also is similar (Fitzhugh et al. 1987, Hanks et al. 1983). However, considerable regional variation occurs within the habitat type and further study is needed.

Site quality is low to moderate for *Pinus ponderosa*, depending on soil depth. Potential for livestock grazing and wildlife forage is good, but cover is poor.

Pinus ponderosa/Quercus gambelii Habitat Type (PIPO/QUGA HT; ponderosa pine/Gambel oak)

This is a major, complex habitat type found throughout the study area. It is typified by *Pinus ponderosa* as the climax overstory with *Quercus gambelii* as either a subcanopy tree or as a tall shrub with greater than 5% cover (fig. 9). Four phases are recognized: (1) a typic *Quercus gambelii* (QUGA) phase where *Muhlenbergia longiligula*, *Pinus edulis*, and *Bouteloua gracilis* are scarce or absent; (2) a *Muhlenbergia longiligula* (MULO) phase where *M. longiligula* is well-represented, but *Bouteloua gracilis* and *Pinus edulis* are absent or poorly represented; (3) a *Bouteloua gracilis* (BOGR) phase where *B. gracilis* is common, but *Muhlenbergia longiligula* and *Pinus edulis* are absent; and (4) a *Pinus edulis* (PIED) phase where *P. edulis* is present and the above grasses are absent or scarce.

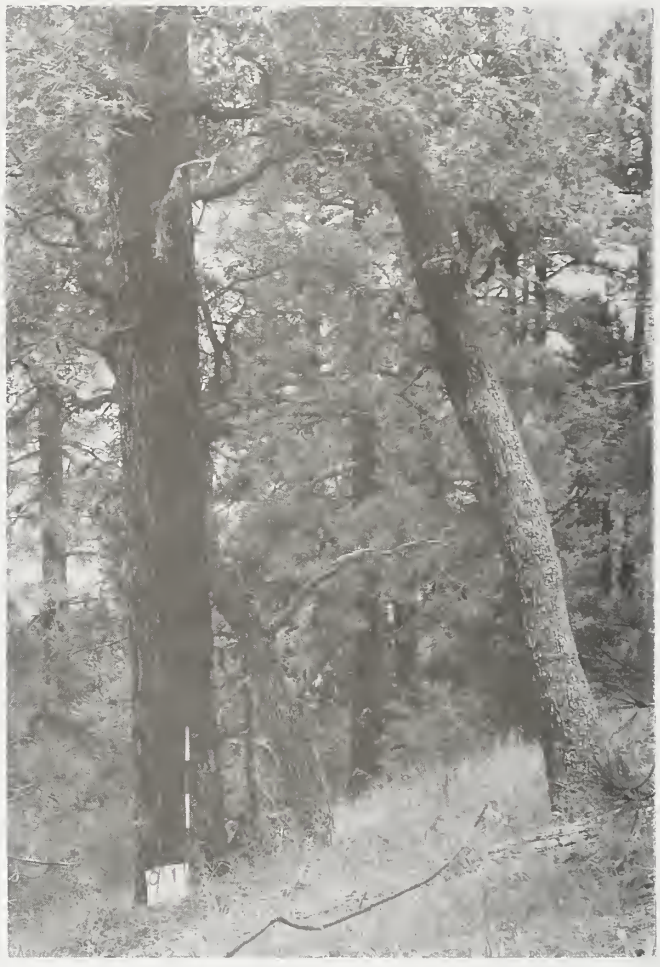

Figure 9.—*Pinus ponderosa/Quercus gambelii* HT along a mid slope in the Rincon Mountains at 7,840 feet (2,390 m). Here *Q. gambelii* is an understory tree; elsewhere it may be the dominant shrub.

Quercus gambelii typic phase (PIPO/QUGA, QUGA PH; Gambel oak)

Geographic location—This phase of the PIPO/QUGA HT is found throughout the study area at upper elevations of the *Pinus ponderosa* series.

Vegetation—The PIPO/QUGA HT, QUGA PH is characteristically shrubby and dominated by a high cover of *Quercus gambelii* in both the subcanopy and tall shrub stratum. *Juniperus deppeana* is commonly a minor climax species; *Pinus edulis* and *P. discolor* are rare. The shrub layer may contain mesic species such as *Symphoricarpos oreophilus*, *Berberis repens*, or *Robinia neomexicana*. The herb layer is diverse (over 80 species have been recorded for this phase) and often luxuriant, with cover values reaching 25% or more. Typical herb species are *Geranium richardsonii*, *G. caespitosum*, *Thalictrum fendleri*, *Carex geophila*, *Koeleria pyramidata*, *Poa fendleri*, *Sitanion hystrix*, and *Bromus richardsonii*. *Muhlenbergia virescens* may be present, but its cover is less than 5%; *Muhlenbergia longiligula* is absent.

Physical setting—This cool, mesic phase is most commonly found at moderate elevations (6,000 to 7,750 feet; 1,830 to 2,360 m), usually on mid to lower canyon slopes with northerly aspects. At higher elevation or latitudes however, it is found on south-

erly aspects. Slopes range from moderate to very steep with shallow to deep, often skeletal soils.

Adjacent habitat types—On wetter or cooler sites this phase grades to the PSME/QUGA HT or habitat types of the *Abies concolor* series; on warmer and/or drier sites it may grade to the PIPO/QUHY, PIPO/QURU, or PIPO/QUAR HTs, and occasionally to the PSME/QUHY or PSME/QURU HTs. On less rocky soils, the phase may grade to the PIPO/MUVI HT.

Comments—This phase is important throughout the southern Rocky Mountains and has been extensively described for New Mexico and southern Colorado (Alexander et al. 1984a, 1987; DeVelice et al. 1986; Fitzhugh et al. 1987). There is considerable heterogeneity in the undergrowth composition of this phase throughout the Southwest, but the unifying characteristic is shrub dominance over grasses. Hess and Wasser (1982) describe a related *Pinus ponderosa/Quercus gambelii/Carex geyeri* habitat type in central Colorado. Youngblood and Mauk (1985) document a similar *Symphoricarpos oreophilus* phase of the PIPO/QUGA HT in central Utah. Steele et al. (1981) describe a weakly related *Pinus ponderosa/Symphoricarpos oreophilus* habitat type in central Idaho.

As with all habitat types in the *Pinus ponderosa* series, fire is an important ecological factor in succession. Soon after intense fire, *Quercus gambelii* forms dense thickets by extensive root sprouting. Severe competition from oaks hinders the establishment of conifers during this persistent shrub stage of succession (Hanks 1966). In certain areas *Quercus gambelii* alone dominates stands with no hint of conifer establishment. These stands may, in fact, represent a *Quercus gambelii* climax series (Brown 1958).

Forage production for livestock in this type is low. Nevertheless, livestock use is common, but dense oak thickets and a general lack of surface water make grazing difficult in many areas. However, *Quercus* stands provide favorable browse and cover for big game and receive moderate to heavy use.

Site quality ranges from poor to moderate. The release of *Quercus gambelii* following overstory removal by clear cutting or seedtree harvest methods severely limits *Pinus ponderosa* regeneration. Shelterwood cutting is recommended to maintain some control over oak development.

Bouteloua gracilis phase (PIPO/QUGA, BOGR PH; blue grama)

Geographic location—This phase is extensive in the Aubrey Cliffs area of the Plateau Region and in the Juniper Mesa-Camp Wood area and Nantanes Plateau of the Central Highlands Region.

Vegetation—The PIPO/QUGA HT, BOGR PH is savanna-like in appearance, and is characterized by open canopies of *Pinus ponderosa*, with *Quercus gambelii* present as a tall shrub or short tree. Large overstory *Q. gambelii* are rare. Clonal patches of *Q. gambelii* are interspersed with open, grassy areas usually dominated by *B. gracilis* in association with *Poa fendleriana, Carex geophila, Sitanion hystrix*, and occasionally *Sporobolus interruptus*. The forb composition is similar to what is often associated with pinyon-juniper savanna and includes *Viguiera multiflora, Heterotheca fulcrata, Eriogonum racemosum, Erigeron divergens*, and *Astragalus* spp.

Physical setting—This mild, dry mesic phase occurs on plateau tops and gentle slopes with relatively shallow soils derived primarily from sandstone or limestone. Elevations range from 6,800 to 7,300 feet (2,075 to 2,230 m).

Adjacent habitat types—On drier sites with steep slopes, there is a shift to the PIPO/QUGA HT, PIED PH or the PIPO/QUAR HT. With descending elevation there can be a gradual transition to the PIPO/BOGR HT where *Quercus gambelii* becomes absent or is minor. With more abrupt changes in elevation, PIPO/QUGA HT, BOGR PH can directly adjoin pinyon-juniper-oak woodlands. On wetter sites with deeper soils, the PIPO/QUGA HT, QUGA PH may occur. As grazing impact increases, there may be a shift to the PIPO/BOGR HT, ARTR PH.

Comments—This phase closely resembles the *Pinus ponderosa/Bouteloua gracilis* HT, *Quercus gambelii* PH as described by Hanks et al. (1983). In their study, the orientation was toward graminoid dominance; in this study, the emphasis is on the shrub layer as a diagnostic feature. Thus, because *Quercus gambelii* is well-represented, this phase is considered part of the PIPO/QUGA HT. Another possibility is that the habitat type of Hanks et al. (1983) may represent a lower oak cover variant of this phase.

Pinus ponderosa productivity is moderate to good, with robust reproduction under the open canopy. However, fires of moderate intensity eliminate much of this reproduction. As a consequence, only a very small percentage of the reproduction reaches canopy height, and it is patchy in distribution. This creates the appearance of a savanna with widely spaced groups of trees. Clearcuts and seedtree cuts can favor dense pole stands of *Pinus ponderosa* that will subsequently require thinning. Shelterwood cutting may prevent overstocking.

The combination of the open canopy and a low to moderate intensity fire regime enhances graminoid production. Grazing potential is high, but subject to shrub invasion with overuse. Wildlife forage is good, but cover is poor and water is often unavailable.

Pinus edulis phase (PIPO/QUGA, PIED PH; pinyon pine)

Geographic location—This minor phase is occasionally found in the Aubrey Cliffs area of the Plateau Region and in the Juniper Mesa-Camp Wood area of the far western Central Highlands Region.

Vegetation—In this phase *Pinus ponderosa* forms a moderately open canopy; *Juniperus deppeana* and *J. osteosperma* occur in the subcanopy as minor climax species. *Quercus gambelii* is well-represented and concentrated in the shrub layer. The undergrowth is distinctly shrubby with *Q. turbinella, Cowania mexicana, Cercocarpus montanus, Ceanothus greggii* and *Robinia neomexicana* often present. This phase lacks the grassy, savanna-like physiognomy of the other phases. *Poa pratensis* and *Carex geophila* can be common, but *Bouteloua gracilis* is absent or scarce. Forbs are scattered and of minor importance; *Penstemon linarioides, Erigeron divergens, Eriogonum racemosum, Solidago sparsiflora,* and *Lotus wrightii* are usually present, but each with less than 1% cover.

Physical setting—This mild, dry mesic phase has been found at elevations from 6,500 to 6,800 feet (1,980 to 2,070 m) on moderate slopes. On the Aubrey Plateau, the phase is localized to plateau side slopes composed of unconsolidated ancient river sediments (as opposed to the sandstone or limestone cap of the plateau tops). In the Juniper Mesa-Camp Wood area, the phase is also is found on plateau side slopes or on lower mountain slopes composed of limestone, sandstone, or rhyolite.

Adjacent habitat types—This phase adjoins the PIPO/QUGA HT, BOGR PH on plateau tops and lower slopes. On drier, warmer sites it may grade to the PIPO/BOGR HT or directly to pinyon-juniper-oak woodland.

Comments—This phase has been previously described by DeVelice et al. (1986) for southern New Mexico and southern Colorado. It is similar to the *Pinus ponderosa/Bouteloua gracilis* HT *Pinus edulis* PH described by Hanks et al. (1983). But, the greater cover of *Q. gambelii* (over 5%) and the poor representation of *B. gracilis* in plots of this study preclude placing them in the habitat type described by Hanks et al. (1983).

Timber productivity is poor on these cobbly soils, although reproduction is strong. Shelterwood cutting will favor regeneration, while clear cutting or seedtree cuts will enhance shrub establishment. Grazing potential is low because of steep slopes and limited grass cover. Wildlife habitat is moderate, with a fair amount of forage and cover available.

Muhlenbergia longiligula phase (PIPO/QUGA, MULO PH; longtongue muhly)

Geographic location—This minor phase is found occasionally in the eastern part of the Central Highlands along the Mogollon Rim, and on the Nantanes Plateau.

Vegetation—A partially closed canopy of *Pinus ponderosa,* a moderate subcanopy of *Quercus gambelii,* and a well-represented tall shrub component of *Q. gambelii* characterize this phase. *Juniperus deppeana* is usually present as a minor climax species. *Ceanothus fendleri* is a common shrub, and evergreen oaks are scarce. The herb layer is characteristically grassy and dominated by *Muhlenbergia longiligula* in association with *Poa fendleriana, Sitanion hystrix, Carex geophila,* and *Bromus richardsonii.* The more xeric site condition (compared to the QUGA Typic PH) is further expressed by a scattering of such forbs as *Bahia dissecta, Tragia ramosa, Lotus wrightii, Senecio neomexicanus, Erigeron divergens,* and *Calliandra humilis.*

Physical setting—This mild, dry mesic phase is found on lower slopes at moderate elevations (5,600 to 7,300 feet or 1,710 to 2,230 m). Soils tend to be moderately deep but skeletal.

Adjacent habitat types—On drier sites, this phase intergrades to the PIPO/QUAR or PIPO/QUHY HTs and on wetter, cooler sites to the PIPO/QUGA HT, QUGA Phase.

Comments—The PIPO/QUGA HT, MULO PH described here is a western extension of the phase described by Fitzhugh et al. (1987) for southwestern New Mexico. Site productivity for *Pinus ponderosa* ranges from low to moderate, with usually strong reproduction. Shelterwood cuts will favor pine; clearcuts and seedtree cuts will favor oak scrub and grass. Grazing potential ranges from low to moderate, depending on the degree of canopy closure. Steep slopes and lack of readily available water often prevent significant use.

Pinus ponderosa/Bouteloua gracilis Habitat Type (PIPO/BOGR HT; ponderosa pine/blue grama)

This minor habitat type is most commonly found in the Aubrey Cliffs area of the Plateau Region and

less frequently below the Mogollon Rim. Two phases are recognized: (1) the typical grass-dominated *Bouteloua gracilis* phase, and (2) the shrub dominated *Artemisia tridentata* phase.

Bouteloua gracilis phase (PIPO/BOGR; Typic BOGR Phase; blue grama)

Geographic location—This phase is sporadic in the Plateau and Central Highlands regions.

Vegetation—The BOGR PH is characterized by an open stand of *Pinus ponderosa*, with a subcanopy of *P. edulis, Juniperus deppeana*, or *J. osteosperma*. The undergrowth is characteristically grassy and dominated by *Bouteloua gracilis* in association with *Aristida fendleriana, Carex geophila, Poa fendleriana, Sitanion hystrix*, and *Muhlenbergia montana*. *Quercus* species are absent or poorly represented. The most constant forbs are *Solidago sparsiflora, Plantago patagonica, Erigeron divergens, E. nudiflorus, Eriogonum alatum*, and *Polygonum sawatchense*.

Physical setting—The mild, dry mesic PIPO/BOGR HT, BOGR PH is usually located in wide valley bottoms at the lower elevation range of *Pinus ponderosa* (5,700 to 6,100 feet; 1,740 to 1,860 m). Soils tend to be fine-textured and often developed from alluvium.

Adjacent habitat types—At lower elevations, this phase grades to pinyon-juniper-oak woodlands and at higher elevations, to the PIPO/QUGA HT, or other *Pinus ponderosa* habitat types.

Comments—This phase is more extensive to the north and west of the study area and has been described in detail by Hanks et al. (1983) for northern Arizona, and by Alexander et al. (1987), DeVelice et al. (1986), and Fitzhugh et al. (1987) for New Mexico. It is also closely related to the PIPO/QUGA HT, BOGR PH described above and is differentiated from it primarily by the poor representation of *Quercus gambelii*.

Site productivity for *Pinus ponderosa* tends to be low and shelterwood cutting is probably the best method to ensure reproduction. Grazing potential is good and wildlife habitat quality is moderate (this phase is often important for turkey). There is fuelwood potential for *Juniperus* spp., but regeneration may be slow.

Artemisia tridentata phase (PIPO/BOGR, ARTR Phase; big sagebrush)

Geographic location—This phase, though common elsewhere in the Plateau Region, is restricted in this study to the Aubrey Cliffs area.

Vegetation—This phase is similar to BOGR PH except that *Artemisia tridentata* is well-represented as a shrub. The graminoid cover, particularly *Bouteloua gracilis*, is reduced and replaced by a wide variety of forbs.

Physical setting—The mild, dry mesic phase is found in wide valley bottoms where soils are relatively deep. The elevation is usually about 6,500 feet (1,980 m).

Adjacent habitat types—The most common adjacent habitat types at similar or more mesic sites are the PIPO/BOGR HT, BOGR PH or the PIPO/QUGA HT. At lower elevations and drier sites the PIPO/BOGR HT, ARTR PH may also adjoin pinyon-juniper woodlands, oak scrub, or chaparral.

Comments—This phase has been previously described for the Mogollon Plateau by Hanks et al. (1983). Site productivity is similar to that of the BOGR PH, except that the grazing and wildlife potential is greatly reduced. This phase may represent a persistent grazing disclimax.

Pinus ponderosa/Juglans major Habitat Type (PIPO/JUMA HT; ponderosa pine/Arizona walnut)

Geographic location—This minor habitat type is sporadic south of the Mogollon Rim.

Vegetation—This is a semiriparian habitat type where *Pinus ponderosa* is the overstory dominant. *Juglans major* is the subcanopy dominant, often in association with *Acer negundo, Quercus* spp., and *Juniperus* spp. Common shrubs are *Vitis arizonica, Rhamnus betulaefolia*, and *Rhus aromatica*. The herb layer is distinctively grassy and dominated by *Poa pratensis, Panicum bulbosum, Bromus richardsonii*, and *Agropyron smithii*. There can be a diverse, but variable, assortment of forbs; *Geranium caespitosum, Galium asperrimum, Pteridium aquilinum, Thalictrum fendleri*, and *Potentilla* spp. are most common.

Physical setting—This HT occupies alluvial terraces along perennial streams or large washes. Elevation ranges between 5,500 and 6,400 (1,680 and 1,950 m).

Adjacent habitat types—The mild, moist mesic PIPO/JUMA HT may adjoin a wide variety of habitat types Up slope from the stream channel, including the PIPO/BOGR HT, *Pinus ponderosa/Quercus* species habitat types, or woodlands and grasslands.

Comments—This is a broadly defined habitat type which needs refinement. It is similar to the *Pinus ponderosa/Poa pratensis* habitat type defined by DeVelice et al. (1986) as part of a northern New Mexico/southern Colorado riparian forest group. Fitzhugh et al. (1987)

broadly defined a *Populus angustifolia* series for southwestern New Mexico, which includes semiriparian communities dominated by *Pinus ponderosa*. Alexander et al. (1987) has also defined a similar *Pinus ponderosa*/ Riparian habitat type for central New Mexico.

Productivity can be high for *Pinus ponderosa* if the soils are not saturated. Reproduction of *P. ponderosa* may be dependent on flooding events creating mineral seedbeds on lower, newly created alluvial terraces. Reproduction may be limited by high competition with grasses and forbs for space and water. The closed canopies also create a shady environment that is not conducive for the growth of this shade-intolerant species. This HT is prime livestock and wildlife habitat because forage, cover, and water are plentiful.

Pinus ponderosa/*Acer grandidentatum* Habitat Type (PIPO/ACGR HT; ponderosa pine/bigtooth maple)

Geographic location—This minor habitat type is uncommon, occurring in the Galiuro Mountains. It may possibly occur in other mountains of the Basin Ranges Region.

Vegetation—*Pinus ponderosa* forms the climax overstory with *Acer grandidentatum* in the subcanopy. The undergrowth is characteristically shrubby and dominated by *Acer grandidentatum* along with *Symphoricarpos oreophilus, Rhus choriophylla, Fraxinus pennsylvanica, Quercus gambelii, Q. hypoleucoides, Q. rugosa, Juglans major*, and *Ptelea trifoliata*. The herb layer is distinctly grassy and codominated by *Muhlenbergia longiligula* and *Poa fendleriana*. Other grasses and forbs include *Bromus richardsonii, Koeleria pyramidata, Artemisia ludoviciana, Brickellia grandiflora, Geranium caespitosum, Monarda menthaefolia, Thalictrum fendleri*, and *Solidago sparsiflora*.

Physical setting—The mild, moist mesic PIPO/ ACGR HT is found along perennial streams on steep, lower slopes of northerly aspects. Elevation ranges from 6,050 to 6,150 feet (1,840 to 1,880 m).

Adjacent habitat types—Other habitat types of the *Pinus ponderosa* series or woodlands may adjoin the PIPO/ACGR HT.

Comments—This is a rare habitat type in the Southwest and is probably more common in Mexico.

Productivity for *Pinus ponderosa* is low. Forage and cover are excellent for wildlife.

Pinus ponderosa/*Quercus rugosa* Habitat Type (PIPO/QURU HT; ponderosa pine/netleaf oak)

Geographic location—This minor habitat type is uncommon in the Santa Catalina, Santa Rita, Huachuca, Pinaleno and Galiuro Mountains, and on the southern edge of the Nantanes Plateau of the Basin Ranges Region.

Vegetation—*Pinus ponderosa* is the climax dominant with *Pseudotsuga* sometimes present, but not well-represented. *Pinus strobiformis* is occasionally a minor climax species. The undergrowth is shrubby and characterized by *Quercus rugosa*, ranging in cover from 5% to 80%. *Quercus hypoleucoides* may codominate, but more than 5% cover of *Q. rugosa* is diagnostic. *Quercus arizonica* or *Q. gambelii* are absent or scarce. Herbaceous cover is generally low (less than 1%) and dominated by graminoids with scattered forbs; the most constant species are *Muhlenbergia virescens, Carex geophila, Geranium caespitosum, Thalictrum fendleri*, and *Hedeoma hyssopifolium*.

Physical setting—This mild, dry mesic habitat type is usually found on moderately steep, mid to upper slopes at elevations ranging from 5,200 to 8,800 feet (1,590 to 2,700 m). Soils are usually shallow and rocky, but not lithic.

Adjacent habitat types—On warmer slopes and lower elevations, this type grades into the PIPO/ QUHY HT. On cooler, wetter, or higher elevation sites, the PIPO/QURU HT adjoins either the PSME/ QURU, PIPO/QUGA, or PIPO/MUVI HTs.

Comments—The PIPO/QURU HT represents the highest elevation type of the *Pinus ponderosa* habitat types that have evergreen oak undergrowth. Often there is a distinct elevational stratification of the oaks in a mountain range, with the deciduous *Quercus gambelii* at the highest elevations. The next highest is *Q. rugosa*, then *Q. hypoleucoides* at moderate elevations, *Q. arizonica* at moderate to low elevations, and finally, *Q. emoryi* at the lowest elevations. The PIPO/QURU HT is restricted to the southern mountain ranges of the study area. To the north, the PIPO/QUAR HT replaces both the PIPO/ QURU and the PIPO/QUHY HTs.

Timber productivity is low and grazing potential is limited because of steep slopes and rocky soils. Clearcuts and seedtree cuts will heavily favor oak regeneration. Shelterwood cuts will usually favor *Pinus ponderosa*. Wildlife habitat is fair to poor, providing adequate cover but limited forage and water.

Pinus ponderosa/*Quercus hypoleucoides* Habitat Type (PIPO/QUHY HT; ponderosa pine/silverleaf oak)

Geographic location—This major habitat type is found extensively in the Santa Catalina, Santa Rita,

Galiuro, Pinaleno, Chiricahua, and Huachuca Mountains, and occasionally on the southern edge of the Nantanes Plateau of the Basin Ranges Region. It is also known in the Pinal Mountains and is uncommon along the eastern Mogollon Rim in the Central Highlands.

Vegetation—*Pinus ponderosa* is the climax overstory dominant. *Pinus strobiformis* is occasionally a codominant. *Pseudotsuga menziesii, Pinus leiophylla,* and *Pinus engelmannii* are absent or accidental. *Juniperus deppeana* is often present as a minor climax species in the subcanopy. *Quercus hypoleucoides* is dominant in the undergrowth, reaching coverage as high as 60%. *Quercus arizonica* can be well-represented, but it is either not dominant, or is clearly successional; *Quercus rugosa* can be present, but usually is poorly represented and never dominant. Other common shrubs are *Nolina microcarpa, Arbutus arizonica, Ceanothus fendleri,* and *Garrya wrightii. Muhlenbergia longiligula* is common and typically dominates the otherwise sparse herb layer. *Muhlenbergia virescens* may be present but is not dominant. The most constant forbs are *Hedeoma hyssopifolium, Pseudocymopterus montanus,* and *Comandra umbellata.*

Physical setting—The mild, dry mesic PIPO/QUHY HT occurs in the mid elevation range of the *Pinus ponderosa* series within the study area. Elevations vary from 5,700 to 8,000 feet (1,740 to 2,440 m). Slopes range from moderate to very steep, and all aspects and landscape positions are encountered. Soils are predominantly Udic Haplustalfs, Udic Ustochrepts, and Lithic Ustochrepts derived from granite, rhyolite, or their metamorphic derivatives.

Adjacent habitat types—Under cooler conditions, *Quercus rugosa* or *Q. gambelii* dominate over *Q. hypoleucoides,* with a shift to *Pinus ponderosa* habitat types characterized by these more mesophytic oaks. In contrast, drier settings to the north feature the PIPO/QUAR or PIPO/QUEM HTs and to the south, habitat types of the *Pinus leiophylla* and *Pinus engelmannii* series.

Comments—Wallmo (1955) and Whittaker and Niering (1965) have described similar communities for the Huachuca and Santa Catalina Mountains, respectively. The PIPO/QUHY HT is one of the most widespread habitat types for the *Pinus ponderosa* series in the southern part of the study area. To the north, in central Arizona, *Quercus hypoleucoides* is absent and the type is ecologically replaced by the PIPO/QUAR HT.

Timber productivity is usually low. Clearcuts and seedtree cuts will favor oak regeneration and inhibit *Pinus ponderosa* reproduction. Shelterwood cuts can be successful if the canopy remains closed enough to suppress oak proliferation but not the development of *Pinus ponderosa.* Cover is abundant, but overall forage and water availability are factors that limit wildlife habitat.

Pinus ponderosa/Quercus arizonica Habitat Type (PIPO/QUAR HT; ponderosa pine/Arizona white oak)

This major habitat type is widespread in the Central Highlands (Sierra Ancha, Mazatzal Mountains, Bradshaw Mountains, along the base of the Mogollon Rim, and on the Nantanes Plateau). It is uncommon or absent in the Basin Ranges and Plateau Regions. *Pinus ponderosa* and *Juniperus deppeana* typify the coniferous overstory. The shrub layer is characterized by the dominance of the xeric oak *Quercus arizonica.* Two phases are recognized: (1) the typic *Quercus arizonica* phase (QUAR), and (2) the *Bouteloua gracilis* phase (BOGR).

Quercus arizonica typic phase (PIPO/QUAR, QUAR PH; Arizona white oak)

Geographic location—This typic phase is the most common habitat type of *Pinus ponderosa* series in the Central Highlands. It is rare in the Basin Ranges Region.

Vegetation—The PIPO/QUAR HT, QUAR PH is characterized by a moderately dense canopy of *Pinus ponderosa* with *Juniperus deppeana* in the subcanopy. The undergrowth is shrubby and dominated by *Quercus arizonica. Quercus hypoleucoides, Q. rugosa,* and *Q. gambelii* may be present, but their covers seldom exceeds 1%. *Quercus emoryi* and *Q. turbinella* may also be present as seral species, but in climax stands their cover is less than 5%. The herb layer is of low cover, highly diverse (over 100 species were encountered for this phase), but variable. *Muhlenbergia longiligula* is usually the common undergrowth dominant in association with several other graminoid species such as *Carex geophila, Poa fendleriana, Koeleria pyramidata, Sitanion hystrix,* and occasionally *Aristida orcuttiana.* Highly constant forbs species are *Senecio neomexicana, Artemisia carruthii, A. ludoviciana, Comandra umbellata, Solidago sparsiflora,* and *Lotus wrightii.*

Physical setting—This mild, dry mesic phase occupies the lower to mid elevation zone for the ponderosa pine-evergreen oak habitat types. Elevation ranges from 5,380 to 7,750 feet (1,640 to 2,360 m). Landscape position is highly variable and dependent

on latitude and local geomorphology. Sites tend toward mid slopes with xeric, rocky, shallow soils represented by Udic Haplustalfs, and Lithic or Udic Ustochrepts.

Adjacent habitat types—At higher elevations of the Central Highlands, this phase of the PIPO/QUAR HT adjoins the PIPO/QUGA HT, QUGA PH, or the PSME/QUAR HT; the PIPO/QUHY and PIPO/QURU HTs are absent. At lower, warmer sites, this phase grades to the PIPO/QUEM HT, and occasionally the PIPO/ARPU HT. The exception is on limestone parent materials, where the PIPO/QUEM HT is poorly expressed. In this instance the PIPO/QUAR HT, QUAR PH can be found at very low elevations, bordering pinyon-juniper-oak woodlands or chaparral.

In the Basin Ranges Region the PIPO/QUAR HT, QUAR PH merges to the PIPO/QUHY HT at upper elevations. At lower elevations and more xeric sites, either the PILE/QUHY or PILE/QUAR HTs, or *Pinus discolor-Juniperus deppeana* woodland may adjoin this type.

Comments—In southwestern New Mexico, Fitzhugh et al. (1987) described a *Pinus ponderosa/Quercus grisea* HT *Muhlenbergia longiligula* Phase that is very similar to the PIPO/QUAR HT, QUAR PH. The primary difference is the presence of the closely related *Quercus grisea* instead of *Q. arizonica* as the dominant oak.

The xeric nature of the PIPO/QUAR HT, QUAR PH results in low site productivity for *Pinus ponderosa*. Competition for moisture and suppression by *Quercus* spp. may severely hinder pine reproduction. Low intensity ground fires that do not destroy the canopy play an important role in creating a seed bed for *Pinus ponderosa*. High intensity fires will favor oak scrub proliferation and hinder pine reproduction. Clearcuts and seedtree cuts may also foster oak scrub. Therefore, shelterwood cutting may possibly be the best method to ensure continued timber productivity. Fuelwood productivity for *Juniperus deppeana* is high. Grazing potential is low because of the nonpalatability of coarse, xeric grasses such as *Muhlenbergia longiligula*. Furthermore, this phase is sensitive to overgrazing because recovery is slow upon release from grazing. Wildlife habitat quality is low to moderate; cover is adequate, but forage potential and water availability are variable.

Bouteloua gracilis phase (PIPO/QUAR, BOGR PH; blue grama)

Geographic location—This phase of the PIPO/QUAR HT is known only from the eastern Nantanes Plateau.

Vegetation—This phase resembles a savanna-like landscape, with an open canopy of *Pinus ponderosa*, a subcanopy of *Juniperus deppeana*, and occasionally *Pinus edulis*. *Quercus arizonica* is the dominant shrub and can also form part of the subcanopy. The herb layer is characterized by a well-represented to abundant cover of *Bouteloua gracilis*; *Bouteloua curtipendula* and *Sitanion hystrix* may also be common. Forbs are diverse and variable; the most constant species are *Ambrosia psilostachya*, *Polygonum sawatchense*, *Calliandra humilis*, *Sphaeralcea* spp. and *Machaeranthera pinnatifida*.

Physical setting—This mild, dry mesic phase is found at low elevations (5,700 to 6,100 feet; 1,740 to 1,860 m) on gentle slopes with northerly aspects. The typical landscapes for this phase are long, low sloping bajadas, which begin at the base of mountains and terminate in open, flat and wide valley bottoms.

Adjacent habitat types—Up slope, this phase grades to the QUAR PH of the habitat type, or to the PIPO/QUHY HT, or occasionally to the PIPO/QUGA HT. Down slope, adjoining HTs may either be the PIPO/BOGR HT, the PIPO/JUMA HT, pinyon-juniper-oak woodlands, or *Bouteloua gracilis* grasslands.

Comments—In southwestern New Mexico, Fitzhugh et al. (1987) described a *Pinus ponderosa/Bouteloua gracilis* HT *Vitis arizonica* PH on the basis of one plot. Evidence from this study suggests that this single plot could be reassigned to the PIPO/QUAR HT, BOGR PH based on the high cover of *Quercus grisea* and *Bouteloua curtipendula* and the landscape position.

The PIPO/QUAR, BOGR PH has low to moderate timber potential, depending on soil depth and rockiness. Large trees are possible where alluvial deposits are deep and soils are well-developed. Grazing potential is high, and the type is somewhat robust in response to grazing pressure. Wildlife habitat is moderate, with limited cover but ample forage.

Pinus ponderosa/*Quercus emoryi* Habitat Type (PIPO/QUEM HT; ponderosa pine/Emory oak)

Geographic location—This major habitat type is extensive in the Central Highlands (Sierra Ancha, Mazatzal Mountains, along the base of the Mogollon Rim, the Bradshaw Mountains, and on the Nantanes Plateau). It is rare in the Basin Ranges Region.

Vegetation—This type is characterized by a moderately closed canopy of *Pinus ponderosa* and a subcanopy of *Quercus emoryi*, *Q. arizonica*, and *Juniperus deppeana*. *Quercus arizonica* often dominates

over *Q. emoryi*, but the presence of *Q. emoryi* with greater than 5% cover is diagnostic. At lower elevations, the representation of *Q. emoryi* increases and *Q. gambelii* is absent or scarce. Other common shrubs are *Ceanothus fendleri, Garrya wrightii* and *Arctostaphylos spp.* The herb layer is diverse (over 80 species for the HT) but sparse and variable. The most constant species are *Muhlenbergia longiligula, Poa fendleriana, Carex geophila, Solidago sparsiflora, Senecio neomexicanus, Artemisia ludoviciana,* and *Lotus wrightii.*

Physical setting—This warm, very dry mesic habitat type is located at the lower elevational limit of the *Pinus ponderosa* series, ranging from 5,300 to 6,900 feet (1,620 to 2,100 m). It is most commonly found on mid to lower slopes, and on dry, upper alluvial benches. Soils are shallow, skeletal, and derived from a wide variety of parent materials (except limestone).

Adjacent habitat types—With increasing elevation and coolness, or with a shift to limestone from other parent materials, the type is replaced by the PIPO/QUAR HT. On more xeric sites with higher fire frequency and very lithic soils, this type may adjoin the PIPO/ARPU HT. At lower elevations, the PIPO/QUEM HT grades to *Quercus emoryi-Q. arizonica* woodlands or to chaparral dominated by *Arctostaphylos* spp. and *Cercocarpus* spp.

Comments—The PIPO/QUEM HT is closely related to the PIPO/QUAR HT. It is differentiated primarily on the basis of higher cover of *Quercus emoryi* (*Q. emoryi* is often absent in the PIPO/QUAR HT) and the lower elevation, more xeric nature of this type.

Site quality is low, except where the type is found on upper alluvial benches. Here the soils are deeper and better watered. This, combined with a warmer temperature regime, can lead to moderate productivity for *Pinus ponderosa*. Clearcuts and seedtree cuts may favor oak chaparral at the expense of pine reproduction. Shelterwood cuts may favor *Pinus ponderosa* regeneration. Fuelwood potential is good. Grazing potential is low. Wildlife habitat is poor to moderate, with adequate cover but low forage potential.

Pinus ponderosa/Arctostaphylos pungens Habitat Type (PIPO/ARPU HT; ponderosa pine/pointleaf manzanita)

Geographic location—This minor habitat type is scattered throughout the study area; but it is particularly common in the Central Highlands along the Mogollon Rim, on the Nantanes Plateau, and in the Mazatzal Mountains.

Vegetation—The overstory of this type is characterized by open stands of *Pinus ponderosa* with an understory of *Juniperus deppeana, Pinus edulis,* and vigorous *P. ponderosa* regeneration. The presence of *Arctostaphylos pungens* and/or *A. pringlei* in the shrub strata with greater than 5% cover is diagnostic (fig. 10) . These species form a montane chaparral undergrowth along with other species, such as *Ceanothus fendleri, Rhamnus crocea, Cercocarpus montanus,* and *Garrya wrightii. Quercus arizonica* and *Q. emoryi* are usually present and often well-represented. The herbaceous layer, in contrast, is poorly represented with scattered forbs and grasses. The most constant species are *Solidago sparsiflora, Senecio neomexicanus, Lo-*

Figure 10.—*Pinus ponderosa/Arctostaphylos pungens* HT on the Nantanes Plateau at 6,650 feet (2,020 m). The canopy is very open and fire-induced shrubs dominate the understory.

tus wrightii, Artemisia carruthii, Bahia dissecta, Gilia aggregata, Hieracium fendleri, Koeleria pyramidata, and *Poa fendleriana.*

Physical setting—The warm, xeric PIPO/ARPU HT is usually found at low to moderate elevations (5,000 to 7,100 feet or 1,520 to 2,160 m). Aspects range from northerly at lower elevations to southerly at the upper elevational limit. The most common landscape positions are moderately steep upper slopes and plateau tops. Soils tend to be lithic and derived from sandstone, granite, or other coarse parent materials.

Adjacent habitat types—On warmer and drier sites, the PIPO/ARPU HT grades to montane chaparral or oak woodlands. On cooler sites, this HT adjoins PIPO/QUAR, PIPO/QUEM, or PIPO/QUHY HTs, or more rarely the PIPO/QUGA HT.

Comments—In the absence of fire, vegetation composition of the PIPO/ARPU HT may undergo succession to various *Pinus ponderosa/Quercus* spp. habitat types, depending on local landscape conditions. Where the soils are deep enough, the direction is usually toward the PIPO/QUEM HT. *Arctostaphylos* spp. are long-lived shrubs that typically require fire to regenerate. If fire frequency remains high, *Arctostaphylos* spp. will be maintained on the site indefinitely, and pine regeneration will be minimal. Fire suppression promotes canopy closure by *Pinus ponderosa,* resulting in the decline of *Arctostaphylos* spp. and an increase in the cover of *Quercus* spp.

Fitzhugh et al. (1987) and Hanks et al. (1983) have loosely described a *Pinus ponderosa/Arctostaphylos pungens* community type from the Mogollon Plateau with a strong *Quercus gambelii* component. The PIPO/ARPU HT described here may represent a different phase of their community type where evergreen oaks are diagnostic. One of the plots assigned to this type by Fitzhugh et al. (1987) should be re-assigned to the PIPO/QURU HT described above.

Timber productivity in this type is very low because of lithic, undeveloped soils. Clearcuts and seedtree cuts will favor *Arctostaphylos* spp., particularly in conjunction with fire. Even the use of shelterwood cuts may only provide marginal control of shrubs. Grazing potential is also low, but wildlife habitat is adequate, with forage and cover provided by shrubs.

Pinus engelmannii Series

This series is known only from southeastern Arizona and southwestern New Mexico. However, it is a common, often dominant series in northern Mexico. It occupies the elevation zone between the *Pinus ponderosa* and *P. leiophylla* series, but is sporadic in occurrence. *Pinus ponderosa* can be a climax codominant; *P. leiophylla* is absent or a minor seral species. Other common associates of the series are *Juniperus deppeana, Pinus discolor,* and *Arbutus arizonica.* Undergrowth tends to be shrubby and dominated by evergreen oaks (*Quercus emoryi, Q. hypoleucoides, Q. arizonica,* and *Q. rugosa*). No habitat types have been previously described for the *Pinus engelmannii* series. Layser and Schubert (1979) included *P. engelmannii* within the *Pinus leiophylla* series, but the distinctive composition and environmental setting warrant series-level designation.

Pinus engelmannii/Quercus rugosa Habitat Type (PINEN/QURU HT; Apache pine/netleaf oak)

Geographic location—This habitat type is rare and is presently known only in the Santa Rita Mountains of the Basin Ranges.

Vegetation—This HT supports an open canopy of *Pinus engelmannii* with an undergrowth dominated by abundant *Quercus rugosa* shrubs. *Quercus arizonica* and *Q. hypoleucoides* are common, but not dominant. *Muhlenbergia longiligula* is well-represented in the herb layer, but there are few other grasses or forbs.

Physical setting—This cool, dry mesic habitat type is located on steep, southerly slopes at approximately 7,880 feet (2,400 m). In this habitat type, the upper elevation limit of *Pinus engelmannii* at this latitude is reached.

Adjacent habitat types—At higher elevations, the PIEN/QURU adjoins PIPO/QURU or PIPO/QUGA HTs. At lower elevations, adjacent habitat types are PINEN/QUHY or PILE/QUHY HTs.

Comments—The PINEN/QURU HT is more common in northern Mexico and is found only peripherally in the United States. The above description is preliminary and more study is needed.

Pinus engelmannii/Quercus hypoleucoides Habitat Type (PINEN/QUHY HT; Apache pine/silverleaf oak)

Geographic location—This is the most common habitat type of the series, and is found in the Santa Rita and Chiricahua Mountains of the Basin Ranges.

Vegetation—This HT is characterized by open stands with *Pinus engelmannii* as the climax dominant. *Pinus leiophylla* is a minor seral species that of-

ten appears as a codominant in the stand. *Quercus hypoleucoides* dominates the subcanopy and shrub layer; *Q. arizonica* is common, but never dominant. Other shrubs may include *Arbutus arizonica* and *Garrya wrightii*. *Muhlenbergia longiligula* is well-represented and dominates the herb layer, which is otherwise diverse, variable, and sparse.

Physical setting—The warm, dry mesic PINEN/QUHY HT is found on moderate to steep slopes of northerly aspects or on benches. Elevations range from 5,800 to 7,100 feet (1,700 to 2,200 m). Soils are predominantly skeletal Ustochrepts.

Adjacent habitat types—This HT grades to the PILE/QUHY HT or to oak woodlands on drier sites. On cooler sites, this type may grade to the PIPO/QUHY HT.

Comments—*Pinus engelmannii* is at the northern limit of its range in southern Arizona. As a consequence, its overall productivity and stature are lower than that found at the center of its range in Mexico. Relative to other habitat types of this series, site productivity is the highest in the PINEN/QUHY HT, with its cooler, more mesic conditions. Grazing potential is low; wildlife forage is limited, but cover is good.

Pinus engelmannii/Muhlenbergia longiligula Habitat Type (PINEN/MULO HT; Apache pine/longtongue muhly)

Geographic location—This broadly defined habitat type is known from the Canelo Hills plus the Santa Rita and the Chiricahua Mountains of the Basin Ranges.

Vegetation—This HT is characterized by an open canopy of *Pinus engelmannii* with *P. discolor*, *P. edulis* or *Juniperus deppeana* in the understory. *Quercus emoryi*, *Q. arizonica*, or *Quercus gambelii* may be common to well-represented as shrubs. The herb layer is characteristically grassy, with *Muhlenbergia longiligula* well-represented and dominant (fig. 11). *Muhlenbergia emersleyi* and *Panicum bulbosum* may also be well-represented, but the remainder of the herbs present are sparse and scattered.

Physical setting—The warm, xeric PINEN/MULO HT is found on northeasterly slopes or dry benches. Elevations range from 5,560 to 6,900 feet (1,690 to 2,100 m).

Adjacent habitat types—Drier sites feature either the PILE/QUAR HT or pinyon-juniper-oak woodlands. On more mesic sites this HT adjoins the PILE/PIFI HT and, in some cases, the PILE/QUHY HT.

Comments—Three tentative phases are outlined: (1) the upper-elevation typical *Muhlenbergia longiligula* phase (MULO PH) where *M. Longiligula* and *Panicum bulbosum* are well-represented and *Quercus gambelii* is common; (2) an intermediate-elevation *Quercus arizonica* phase (QUAR PH), with *Piptochaetium fimbriatum* common; and (3) a low-elevation, *Quercus emoryi* phase (QUEM PH), where *Muhlenbergia longiligula* and *M. emersleyi* codominate in the herb layer. Further research is needed to confirm these phases.

Figure 11.—*Pinus engelmannii/Muhlenbergia longiligula* HT in the Chiricahua Mountains at 6,900 feet (2,100 m). Grasses dominate beneath an open canopy.

Pinus leiophylla Series

The *Pinus leiophylla* series is the most xeric of the conifer series discussed here. It is common in the

Basin Ranges Region, and it is sporadic and uncommon along the Mogollon Rim of the Central Highlands. *Pinus leiophylla* is a relatively short-lived tree of reduced stature relative to *Pinus ponderosa*. Stands are typically very open with an undergrowth of evergreen *Quercus* spp. and/or *Arctostaphylos* spp. *Pinus ponderosa* is commonly a climax codominant, but *Pinus engelmannii* is absent. This series was described by Layser and Schubert (1979), but no habitat types have been previously described.

Pinus leiophylla/Quercus hypoleucoides Habitat Type (PILE/QUHY HT; Chihuahua pine/silverleaf oak)

Geographic location—This major habitat type occurs sporadically in the Canelo Hills; in the Santa Catalina, Santa Rita, Patagonia, Chiricahua, Peloncillo and Huachuca Mountains of the Basin Ranges; and below the Mogollon Rim of the Central Highlands.

Vegetation—The PILE/QUHY HT is characterized by an open canopy of *Pinus leiophylla*. The subcanopy is composed of *P. discolor*, and *Juniperus deppeana* plus the evergreen oaks, *Quercus hypoleucoides* and *Q. arizonica*. The dominance of *Q. hypoleucoides* over *Q. arizonica* is diagnostic. In some cases, *Quercus arizonica* will be absent; *Quercus emoryi* is also absent or rare. Along with evergreen oaks, the shrub layer may contain a variety of xeric species such as *Arbutus arizonica*, *Nolina microcarpa*, *Agave parryi*, *Garrya wrightii*, *Yucca schottii*, *Rhus aromatica*, and *Arctostaphylos* spp. The *Arctostaphylos* spp. cover is generally less than 5%. The herb layer is characterized by xeric grasses such as *Muhlenbergia longiligula*, *M. emersleyi* or *Aristida orcuttiana*; *Piptochaetium fimbriatum* is absent or accidental. Forbs are diverse, variable, and sparse; the most constant are *Hedeoma hyssopifolium*, *Desmodium rosei*, *Cheilanthes fendleri*, *Gnaphalium* spp., and *Senecio neomexicanus*.

Physical setting—In this warm, dry mesic to xeric habitat type, elevations range from 5,700 to 7,100 feet (1,740 to 2,170 m) and slopes are gentle to steep. Exposures range from southerly at high elevations to northerly at low elevations. Soils are generally Udic Ustochrepts.

Adjacent habitat types—Under more mesic conditions, this HT adjoins the PIPO/QUHY HT or occasionally, the PINEN/QUHY HT, and rarely the PSME/QUHY HT. Xeric sites may feature either the PILE/QUAR, PILE/ARPU or PINEN/MULO HTs, or pinyon-juniper-oak woodlands and chaparral.

Comments—This type, in relation to other habitat types of this series, is cooler and more mesic, occupying relatively higher elevations. Fire plays a very important role in maintaining the openness of the stand and shrub dominance in the undergrowth. Site productivity for *Pinus leiophylla* is low. Although *P. leiophylla* sprouts from the rootcrown, this appears to have a negligible effect on reproduction and maintenance of the species. Graminoid biomass is relatively low and the general lack of quality species makes this type poor for livestock use. Wildlife habitat is poor to moderate—sometimes with adequate forage and ample cover but limited water availability.

Pinus leiophylla/Quercus arizonica Habitat Type (PILE/QUAR HT; Chihuahua pine/Arizona white oak)

Geographic location—This is a major habitat type of the series. It is found in the Peloncillo, Chiricahua, and Pinaleno Mountains of the Basin Ranges, and along the base of the Mogollon Rim of the Central Highlands.

Vegetation—*Pinus leiophylla* forms an open canopy with *P. discolor* and *Juniperus deppeana* in the subcanopy. *P. ponderosa* sometimes is present as a climax codominant. The undergrowth is distinctively shrubby and dominated by *Quercus arizonica*; *Q. hypoleucoides* is often abundant but subordinate to *Q. arizonica*. *Quercus emoryi* may also be present, but is usually poorly represented. Along with the evergreen oaks are other xeric shrubs such as *Garrya wrightii*, *Yucca schottii*, *Arctostaphylos pungens*, *Rhus aromatica*, and *Nolina microcarpa*. Xeric grasses are characteristic and include *Schizachyrium cirratum*, *Aristida orcuttiana*, and *Muhlenbergia longiligula*. *Piptochaetium fimbriatum* may be present but poorly represented and not dominant. Forbs are diverse, variable, and scarce in cover; the most constant forbs are *Senecio neomexicanus*, *Gnaphalium* spp., *Solidago sparsiflora*, *Bahia dissecta*, and *Cheilanthes fendleri*.

Physical setting—This warm, xeric habitat type occurs at elevations from 5,250 to 7,100 feet (1,600 to 2,100 m). Slopes vary from steep to very steep, and are of northerly aspect. Soils tend to be rocky and lithic.

Adjacent habitat types—This HT lies approximately at elevations between the PILE/QUHY and PILE/QUEM HTs. The PILE/QUAR HT adjoins either the PILE/QUHY, PIPO/QUEM, or PIPO/QUAR HTs in mesic settings. Under drier conditions or higher fire frequency, the PILE/QUEM or PILE/ARPU HTs may adjoin this HT, or it may grade directly to pinyon-juniper-oak woodlands.

Comments—This is a peripheral habitat type in the United States and is more common in northern Mexico.

As with all habitat types of this series, timber productivity for *Pinus leiophylla* and *P. ponderosa* is low. Grazing potential is also low, with the most common grass species having low palatability. Wildlife habitat is marginal, with adequate cover and forage, but limited water provided.

Pinus leiophylla/Quercus emoryi Habitat Type (PILE/QUEM HT; Chihuahua pine/Emory oak)

Geographic location—This habitat type is occasional on the Naegelin Plateau of the Central Highlands; and in the Canelo Hills, and Patagonia, Pinaleno, Galiuro, Huachuca and Peloncillo Mountains of the Basin Ranges Region.

Vegetation—This HT is characterized by an overstory of *Pinus leiophylla* and a subcanopy of *Pinus discolor* and *Juniperus deppeana. Pinus ponderosa* is occasionally a climax codominant. A diagnostic feature is well-represented to abundant cover of *Quercus emoryi*, which occurs as a small tree or shrub. *Quercus arizonica* is also well-represented and often codominates, but *Quercus hypoleucoides* is poorly represented. Other shrubs include *Arctostaphylos pungens, Arctostaphylos pringlei, Nolina microcarpa, Garrya wrightii*, and *Rhus aromatica*. This type has a distinctively grassy undergrowth dominated by xeric species such as *Muhlenbergia longiligula, Muhlenbergia emersleyi, Aristida orcuttiana*, and *Schizachyrium cirratum*. Forbs are diverse, variable and scattered; the most constant species are *Senecio neomexicanus, Verbena bipinnatifida, Lathyrus graminifolius, Gnaphalium spp.*, and *Cheilanthes fendleri*.

Physical setting—The warm, xeric PILE/QUEM HT reaches the lowest elevations of any habitat type of the series, ranging from 4,960 to 6,450 feet (1,510 to 1,950 m). It is generally found on moderate slopes of northerly aspect. In the southern portion of the study area, the PILE/QUEM occurs on rhyolite and granite; to the north it occurs on sandstone. Soils tend to be shallow and rocky.

Adjacent habitat types—At higher elevations and/or more mesic conditions, this habitat type grades to other types of the *Pinus leiophylla, P. engelmannii*, and *P. ponderosa* series. On warmer, drier sites, the transition is to the PILE/ARPU HT, pinyon-juniper-oak woodlands, or chaparral.

Comments—The PILE/QUEM HT is a very xeric habitat type, and site productivity is very low for *Pinus leiophylla* and *P. ponderosa*. Grazing potential is low because most of the graminoids have low palatability and are sparse. Wildlife habitat value is low to moderate, with adequate cover but low forage value. The wildlife habitat potential may be enhanced because this HT occupies lower slope positions near stream channels where water may be intermittently available.

Pinus leiophylla/Piptochaetium fimbriatum Habitat Type (PILE/PIFI HT; Chihuahua pine/pinyon ricegrass)

Geographic location—This major habitat type is restricted to the Basin Ranges Region and is found in the Canelo Hills, and in the Patagonia, Peloncillo and Chiricahua Mountains.

Vegetation—The PILE/PIFI HT is characterized by an overstory of *Pinus leiophylla* and by a subcanopy of *Juniperus deppeana, J. monosperma, Quercus emoryi, Q. arizonica, Quercus hypoleucoides*, and occasionally *Cupressus arizonica*. Semiriparian, broadleaf trees are sometimes present, including *Juglans major, Fraxinus pennsylvanica* ssp. *velutina, Platanus wrightii*, and *Prunus serotina*. The herb layer is diverse and high in cover; *Piptochaetium fimbriatum* is diagnostic, and it is well-represented and dominant. Other high constancy species include *Muhlenbergia longiligula, Panicum bulbosum, Desmodium* spp., *Galium microphyllum, Monarda pectinata, Senecio neomexicanus, Brickellia lemmonii*, and *Phaseolus wrightii*.

Physical setting—This warm mesic habitat type is restricted to flat or gently sloping streamsides and benches at elevations ranging from 5,000 to 6,000 feet (1,520 to 1,830 m). Soils are generally fluventic and derived from alluvial sediments.

Adjacent habitat types—The PILE/QUEM, PINEN/MULO, or PILE/QUAR HTs, or pinyon-juniper-oak woodlands adjoin this HT on more xeric sites. The PILE/QUHY or PIPO/QUHY HTs are often found directly upslope.

Comments—This is a semiriparian habitat type subject to occasional flooding. In fact, flooding may be required for *Pinus leiophylla* reproduction. Wildlife and livestock use is high because of the diverse vegetation strata, a generally close proximity to water, and abundant forage. This is key habitat in the Chiricahua Mountains for many Mexican bird species at the northern limits of their ranges.

Pinus leiophylla/Arctostaphylos pungens Habitat Type (PILE/ARPU HT; Chihuahua pine/pointleaf manzanita)

Geographic location—This minor habitat type occurs in the Chiricahua, Galiuro, and Santa Catalina

Mountains of the Basin Ranges, and along the slopes of the Mogollon Rim of the Central Highlands.

Vegetation—The PILE/ARPU HT is characterized by a very open stand of *Pinus leiophylla*, with an undergrowth dominated by *Arctostaphylos pungens* and/or *Arctostaphylos pringlei*. *Pinus ponderosa* can be a climax codominant. *Quercus* spp. range from scarce to well-represented, particularly in the shrub layer; but they are not dominant over *Arctostaphylos* spp. The herb layer is characterized by the presence of several xeric graminoid species, including *Muhlenbergia longiligula, M. emersleyi, M. montana, Aristida orcuttiana, Blepharoneuron tricholepis, Schizachyrium cirratum,* and *Schizachyrium scoparium*. Common forbs are *Hedeoma hyssopifolium, Calliandra reticulata, Solidago sparsiflora,* and *Senecio neomexicanus*.

Physical setting—The PILE/ARPU HT is the warmest and most xeric of the habitat types in this study. It is found at low elevations, on plateaus and gentle sideslopes of southerly aspect. Elevations range from 5,100 to 6,900 feet (1,560 to 2,100 m). Soils are extremely lithic and rocky, with the regolith often at less than 4 inches (10 cm) depth. Exposed soil, rock fragments, and cobble may account for 30% to 40% of the surface area.

Adjacent habitat types—In areas that are more mesic, and with a lower fire frequency, other habitat types of the *Pinus leiophylla* and *P. ponderosa* series can be found. On more xeric sites, *Arctostaphylos*-dominated chaparral, or pinyon-juniper-oak woodlands may be encountered.

Comments—A high fire frequency and shallow soils in this HT favor and maintain *Arctostaphylos* spp. over *Quercus* spp. The lack of moisture also favors *Pinus leiophylla* over *P. ponderosa*. Site quality for *P. ponderosa* is extremely low, with most mature trees under 40 feet (12 m) in height. Although forage may be adequate, low water availability limits the potential for livestock and wildlife.

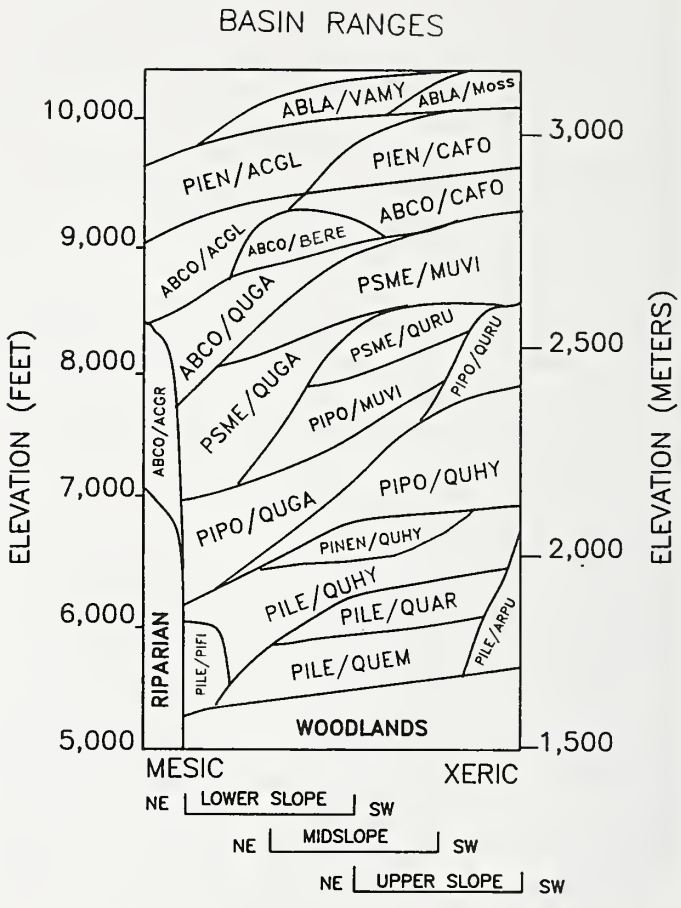

Figure 12.—Schematic representation of environmental relationships among the major habitat types of the Basin Ranges.

DISCUSSION

Regional Floristic and Environmental Relationships

The environmental relationships among the major habitat types within each physiographic region are schematically summarized in figures 12, 13, and 14. The schematics have been derived from direct gradient analysis and indirect ordinations. The relationships shown are simplified representations and should only be considered as guidelines, pending more detailed studies.

The Basin Ranges Region of southeast Arizona is by far the most complex (fig. 12). Habitat types with strong Sierra Madrean floristic influences and that are characterized by evergreen oaks in the undergrowth are predominate at lower elevations. The climate of southeastern Arizona, with its relatively high summer rainfall and warm temperatures, is similar to the climate of the Sierra Madre Occidental in northern Mexico. Thus, the evergreen oak-dominated habitat types are essentially northern extensions of communities commonly found to the south in Mexico. There is an elevation zonation of the evergreen oaks, with *Quercus emoryi*-dominated communities found at the lowest elevations, followed by *Quercus arizonica* at mid elevations, then *Quercus hypoleucoides* and finally *Quercus rugosa* at the highest elevations. Above these oaks, at mesic and/or cool elevations, habitat

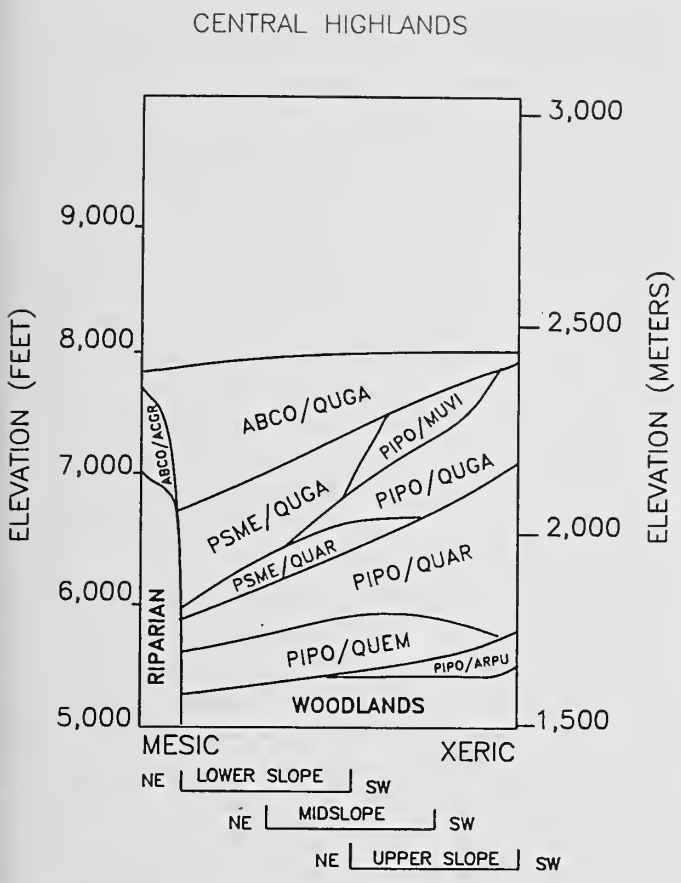

Figure 13.—Schematic representation of environmental relationships among the major habitat types of the Central Highlands.

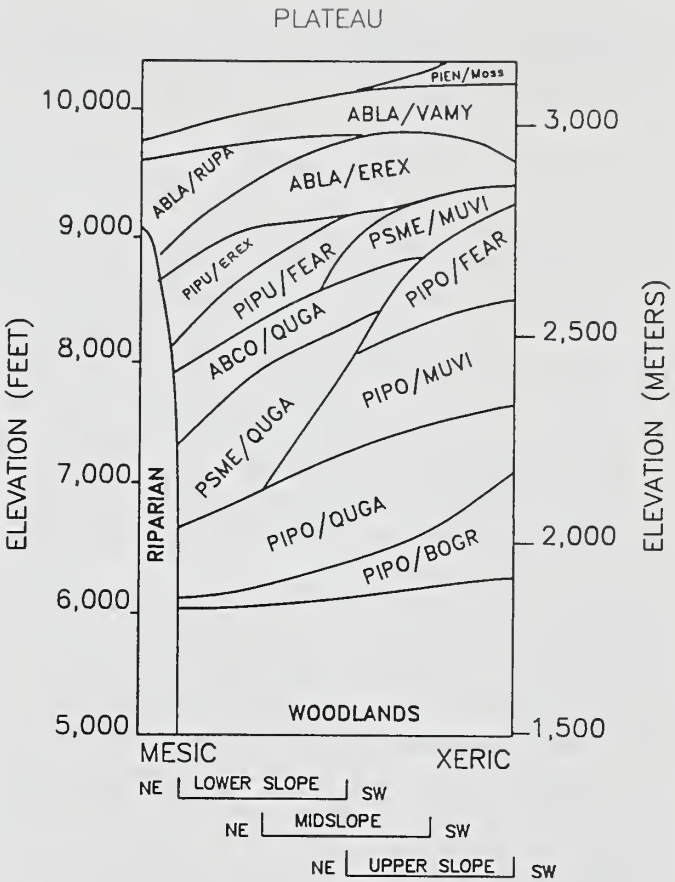

Figure 14.—Schematic representation of environmental relationships among the major habitat types of the Plateau Region.

types dominated by *Muhlenbergia virescens* and the deciduous *Quercus gambelii* prevail. At the region's highest elevations, habitat types with Rocky Mountain floristic affinities, such as the PIEN/ACGL HT or the ABLA/VAMY HT, dominate. These habitat types tend to be somewhat floristically depauperate and are outliers of communities that are more common in the southern Rocky Mountains.

In the Central Highlands, environmental relationships are less complex than in the Basin Ranges Region (fig. 13). The habitat types of the Basin Ranges dominated by *Quercus rugosa* and *Quercus hypoleucoides* are not present. This is probably a function of decreasing summer rainfall and prevailing cooler temperatures, resulting in the elimination of higher elevation habitats which are moist yet warm enough to support these oaks. At lower elevations, much of the winter moisture is lost prior to the summer growing season; the subsequent low summer moisture, coupled with warm temperatures may favor *Quercus emoryi* and *Quercus arizonica*-dominated communities. At higher elevations, adequate moisture and cold temperatures favor ABCO/QUGA and ABCO/BERE HTs. But elevations high enough to support forests in the *Abies lasiocarpa* and *Picea engelmannii* series are never attained in the Central Highlands.

In the Plateau Region, the cooler temperatures almost entirely eliminate Sierra Madrean evergreen oak types (fig. 14). At the lowest elevations, the PIPO/BOGR and PIPO/QUGA HTs predominate. These are common communities further to the north and east. At mid elevation, mesic sites, mixed-conifer habitat types with shrubby undergrowths dominated by *Quercus gambelii* are found (PSME/QUGA and ABCO/QUGA). On drier sites, the grass-dominated communities prevail, such as the PIPO/MUVI, PIPO/FEAR, and PSME/MUVI HTs. The highest elevations support spruce-fir forests of the *Abies*

lasiocarpa and *Picea engelmannii* series. These habitat types are strongly related or identical to many communities of the central or southern Rocky Mountains.

Succession

Successional trends vary widely among habitat types (Appendix C). Succession to *Abies lasiocarpa* or *Picea engelmannii* is direct in the highest (coldest) elevations. At lower, warmer elevations in the *Abies lasiocarpa* and *Picea engelmannii* series, seral stages leading to the climax tree species may be composed of one or more of the following major seral trees: *Populus tremuloides, Abies concolor,* and *Pseudotsuga menziesii.* Occasionally, *Pseudotsuga menziesii* is considered a co-climax species at lower elevations of the *Picea engelmannii* series.

Succession in the mid elevation, mixed-conifer forests—*Picea pungens, Pseudotsuga menziesii,* and *Abies concolor* series—includes the following major seral trees: *Populus tremuloides, Pinus strobiformis, Pinus ponderosa, Quercus gambelii, Q. rugosa,* and *Q. hypoleucoides. Pinus strobiformis* is occasionally considered a coclimax species at lower elevations of the mixed-conifer zone.

At the upper elevations of the *Pinus ponderosa* series, the principal seral trees are *Quercus gambelii, Q. rugosa, Q. hypoleucoides, Q. emoryi,* and *Q. arizonica. Pinus edulis, P. discolor,* and *Juniperus deppeana* may also be successional, depending on the habitat type. At lower elevations of the *Pinus ponderosa* series, and in the *Pinus engelmannii* and *P. leiophylla* series, the *Quercus* species, *Pinus edulis, P. discolor,* and *Juniperus deppeana* are considered coclimax associates of the various habitat types. Moister habitat types in the *Pinus ponderosa* and *Pinus engelmannii* series may be regarded as fire climaxes, because, in the absence of fire, the more shade-tolerant, but less fire-resistant, *Abies concolor* and *Pseudotsuga menziesii* may eventually dominate.

SUMMARY

A comprehensive classification of all forests of southern Arizona and portions of the Colorado Plateau has been developed on the basis of 312 plots located in the Tonto, Prescott and Coronado National Forests; and in the Fort Apache, San Carlos and Hualapai Indian Reservations.

Forty-nine types have been identified and described among the *Abies lasiocarpa, Picea engelmannii, Picea pungens, Abies concolor, Pseudotsuga menziesii, Pinus ponderosa, Pinus engelmannii,* and *Pinus leiophylla* series. Each habitat type is identified by its characteristic plant association. Use of climax plant associations does not imply that we have an abundance of climax vegetation in the present landscape in the western United States (Pfister et al. 1977, Steele et al. 1981). The status of most current vegetation reflects some form of disturbance resulting in various stages of succession towards climax. Indeed, in areas where timber harvesting and overgrazing have been pervasive, the climax vegetation structure is essentially absent, and habitat type identification requires noting relative reproductive success of species present, comparison of known successional trends (Pfister et al. 1977), and extrapolation from adjacent undisturbed stands (Arno 1982).

Environmental and floristic analyses suggest that the habitat types of low elevations in the southeastern Basin Ranges Region of Arizona have strong floristic affinities with the Sierra Madre of northern Mexico. These types tend to be dominated by evergreen oak species which favor warm climates with predominantly summer moisture. In contrast, at higher elevations of the Basin Ranges, habitat types tend to be depauperate in species and more floristically related to the Rocky Mountains. In the Central Highlands Region, the influence of the Sierra Madrean flora diminishes as summer rains and temperatures decline at altitudes equivalent to those in the Basin Ranges. The Plateau Region is dominated by habitat types requiring cool to cold temperatures and relatively high moisture distributed uniformly throughout the seasons. The majority of these habitat types are commonly found to the north and east of the study area in the southern Rocky Mountains.

Since natural vegetation integrates all impinging environmental factors, a given habitat type encompasses a relatively narrow range of environmental variation (Daubenmire 1976). Thus, the classification presented here provides a means of delimiting land units of relatively uniform biotic potential and management opportunities. Additionally, the classification is useful in improving sampling design and experimental layout, and provides a common system for improving communication among diverse investigators.

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APPENDIX A

List of all vascular plant species identified in plots from habitat types of southern Arizona and portions of the Colorado Plateau.

Scientific Name	Common Name	HT Acronym
Abies concolor	white fir	ABCO
Abies lasiocarpa	subalpine fir	ABLA
Abronia spp.	sand verbena	ABRONI
Acer glabrum	Rocky Mountain maple	ACGL
Acer grandidentatum	bigtooth maple	ACGR
Acer negundo	California boxelder	ACNE
Achillea millefolium	common yarrow	ACMI
Actaea rubra	red baneberry	ACRU
Agastache pallidiflora	Bill Williams' Mountain giant	AGPA
Agastache spp.	giant hyssop	AGASTA
Agave chrysantha	goldenflower century plant	AGCR
Agave palmeri	Palmer's century plant	AGPAL
Agave parryi	Parry's agave	AGAPA
Agave parryi	Parry's agave	AGPAR
Agave spp.	agave	AGAVE
Agoseris spp.	agoseris	AGOSER
Agropyron arizonicum	Arizona wheatgrass	AGAR
Agropyron desertorum	desert wheatgrass	AGDE
Agropyron spp.	wheatgrass	AGROPY
Agropyron subsecundum	wheatgrass	AGSU
Agrostis idahoensis	Idaho bentgrass	AGID
Agrostis stolonifera	creeping bentgrass	AGST
Allium cernuum	nodding onion	ALCE
Allium kunthii	Kunth's onion	ALKU
Allium spp.	onion	ALLIUM
Alnus oblongifolia	Arizona alder	ALOB
Amaranthus spp.	pigweed	AMARAN
Ambrosia psilostachya	Cuman ragweed	AMPS
Amelanchier mormonica	Utah service berry	AMUT
Amelanchier oreophila	Utah service berry	AMOR
Amelanchier utahensis	Utah service berry	AMUT
Amorpha fruticosa	desert indigobush	AMFR
Andropogon spp.	big bluestem	ANDROP
Androsace septentrionalis	pygmy flower rock jasmine	ANSE
Antennaria arida	rosy pussytoes	ANAR
Antennaria neglecta	pussytoes	ANNE
Antennaria parvifolia	smallleaf pussytoes	ANPA
Antennaria rosulata	rosy pussytoes	ANRO
Antennaria spp.	pussytoes	ANTENN
Anthericum torreyi	Torrey's craglily	ANTO
Apocynum androsaemifolium	spreading dogbane	APAN
Aquilegia chrysantha	golden columbine	AQCH
Aquilegia elegantula	western red columbine	AQEL
Aquilegia spp.	columbine	AQUILE
Arabis spp.	rockcress	ARABIS
Arabis tricornuta	Rincon Mountain rockcress	ARTRI
Arbutus arizonica	Arizona madrone	ARBAR
Arctostaphylos pringlei	greenleaf manzanita	ARPR
Arctostaphylos pungens	greenleaf manzanita	ARPU
Arenaria eastwoodiae	Eastwood's sandwort	AREA
Arenaria lanuginosa	spreading sandwort	ARLAN
Arenaria spp.	sandwort	ARENAR
Aristida fendleriana	Fendler threeawn	ARFE
Aristida orcuttiana	single threeawn	AROR
Aristida spp.	threeawn	ARISTI
Artemisia carruthii	field sagewort	ARCA
Artemisia dracunculoides	wormwood	ARDR

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Artemisia franserioides	fringed sagewort	ARFR
Artemisia ludoviciana	white sagebrush	ARLU
Artemisia spp.	bud sagebrush	ARTEMI
Artemisia tridentata	big sagebrush	ARTR
Asclepias spp.	showy milkweed	ASCLEP
Asclepias tuberosa	butterfly milkweed	ASTU
Aster bigelovii	Bigelow's tansyaster	ASBI
Aster commutatus	Aster exscapus Richards	ASCO
Aster exilis	annual saltmarsh aster	ASEX
Aster spp.	aster	ASTER
Astragalus cobrensis	Maguire's milkvetch	ASCO
Astragalus hallii	groundcover milkvetch	ASHA
Astragalus recurvus	recurved milkvetch	ASRE
Astragalus tephrodes	creeping milkvetch	ASTE
Astragulus humistratus	groundcover milkvetch	ASHU
Astragulus spp.	milkvetch	ASTRAG
Baccharis thesioides	Arizona baccharis	BATH
Bahia dissecta	ragleaf bahia	BADI
Besseya plantaginea	White River coraldrops	BEPL
Bidens heterosperma	Rocky Mountain beggarticks	BIHE
Bidens lemmonii	Lemmon's beggarticks	BILE
Bidens spp.	beggarticks	BIDENS
Blepharoneuron tricholepis	pine dropseed	BLTR
Boerhaavia spp.	spiderling	BOERHA
Bouteloua barbata	sixweeks grama	BOBA
Bouteloua curtipendula	sideoats grama	BOCU
Bouteloua gracilis	blue grama	BOGR
Bouteloua hirsuta	hairy grama	BOHI
Bouvardia glaberrima	firecrackerbush	BOGL
Brickellia betonicifolia	plumed brickellbush	BRBE
Brickellia brachyphylla	plumed brickellbush	BRBR
Brickellia californica	California brickellbush	BRICA
Brickellia fendleri	Fendler's brickellbush	BRFE
Brickellia grandiflora	tasselflower brickellbush	BRGR
Brickellia lemmonii	longleaf brickellbush	BRLE
Brickellia spp.	Sonoran brickellbush	BRICKE
Bromus porteri	nodding brome	BRPO
Bromus richardsonii	fringed brome	BRRI
Bromus spp.	brome	BROMUS
Bromus tectorum	cheatgrass	BRTE
Cacalia decomposita	cacalia	CACDE
Calliandra humilis	dwarf stickpea	CAHU
Calliandra reticulata	dwarf stickpea	CARE
Calliandra schottii	Schott's stickpea	CALSC
Campanula rotundifolia	bluebell bellflower	CAROT
Carex bella	showy sedge	CABE
Carex brevipes	Ross' sedge	CABR
Carex foenea	dryspike sedge	CAFO
Carex geophila	White Mountain sedge	CAGE
Carex hoodii	Hood's sedge	CAHO
Carex leucodonta	Huachuca Mountain sedge	CALE
Carex rossii	Ross' sedge	CARO
Carex spp.	sedge	CAREX
Carphochaete bigelovii	Bigelow's bristlehead	CABI
Castilleja austromontana	northwestern Indian paintbrush	CAAU
Castilleja confusa	scarlet Indian paintbrush	CACON
Castilleja integra	wholeleaf Indian paintbrush	CAINT
Castilleja linariifolia	marshmeadow Indian paintbrush	CALI2
Castilleja spp.	sulphur Indian paintbrush	CASTIL
Ceanothus fendleri	Fendler's ceanothus	CEFE
Ceanothus greggii	desert ceanothus	CEGR

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Cerastium nutans	nodding chickweed	CENU
Cerastium spp.	chickweed	CERAST
Cercocarpus montanus	littleleaf mountain mahogany	CEMO
Chamaesaracha coronopus	greenleaf five eyes	CHCO
Chaptalia alsophila	sunbonnets	CHALS
Cheilanthes fendleri	rough lipfern	CHFE
Chenopodium fremontii	Fremont's goosefoot	CHFR
Chenopodium incisum	fetid goosefoot	CHIN
Chenopodium spp.	goosefoot	CHENOP
Chimaphila menziesii	striped prince's pine	CHME
Chimaphila umbellata	pipsissewa	CHUM
Cirsium arizonicum	Arizona thistle	CIAR
Cirsium parryi	Parry's thistle	CIPA
Cirsium rothrockii	Rothrock's thistle	CIRO
Cirsium spp.	thistle	CIRSIU
Cirsium undulatum	wavyleaf thistle	CIUN
Cirsium wheeleri	Wheeler's thistle	CIWH
Cirsium wrightii	Wright's thistle	CIWR
Clematis columbiana	rock clematis	CLCO
Cologania longifolia	longleaf cologania	COLO
Cologania pulchella	cologania	COPU
Cologania spp.	cologania	COLOGA
Comandra umbellata s. pallida	bastard toadflax	COUM
Commelina dianthifolia	birdbill dayflower	CODI
Commelina erecta	whitemouth dayflower	COER
Commelina spp.	dayflower	COMMEL
Conopholis mexicana	Mexican squawroot	COME
Conyza schiedeana	horseweed	COSC
Corallorhiza spp.	coralroot	CORALL
Corallorhiza striata	hooded coralroot	COSTR
Cosmos spp.	cosmos	COSMOS
Cowania mexicana	cowania	COWME
Cyperus fendlerianus	Fendler's flatsedge	CYFE
Cyperus rusbyi	Rusby's flatsedge	CYRU
Cyperus spp.	flatsedge	CYPERU
Cystopteris fragilis	bulblet bladderfern	CYFR
Dactylis glomerata	orchardgrass	DAGL
Dalea leporina	foxtail prairieclover	DALE
Dalea spp.	prarieclover	DALEA
Dalea wislizeni	oakwoods prarieclover	DAWI
Dasylirion wheeleri	common sotol	DAWH
Desmanthus cooleyi	Cooley's bundleflower	DECO
Desmodium arizonicum	Arizona ticktrefoil	DEAR
Desmodium batocaulon	San Pedro ticktrefoil	DEBA
Desmodium grahami	grassleaf ticktrefoil	DEGR
Desmodium rosei	Rose's ticktrefoil	DERO
Desmodium spp.	tricktrefoil	DESMOD
Draba aurea	golden whitlowgrass	DRAU
Draba helleriana	Heller's whitlowgrass	DRHE
Draba spp.	whitlowgrass	DRABA
Drymaria tenella	drymary	DRTE
Echinocactus spp.	devilshead	ECHINC
Echinocereus spp.	hedgehog cactus	ECHINO
Echinocerus triglochidiatus	kingcup cactus	ECTR
Elymus spp.	wheatgrass	ELYMUS
Epilobium angustifolium	fireweed	EPAN
Epilobium paniculatum	autumn willowreed	EPPA
Eragrostis intermedia	plains lovegrass	ERIN
Eragrostis spp.	purple lovegrass	ERAGRO
Erigeron caespitosus	tufted fleabane	ERICA
Erigeron divergens	spreading fleabane	ERDI

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Erigeron eximius	sprucefir fleabane	EREX
Erigeron flagellaris	trailing fleabane	ERFL
Erigeran formosissimus	beautiful fleabane	ERFO
Erigeron macranthus	aspen fleabane	ERMA
Erigeran neomexicanus	New Mexico fleabane	ERNE
Erigeron nudiflorus	trailing fleabane	ERNU
Erigeron oreophilus	chaparral fleabane	EROR
Erigeran platyphyllus	Vreeland's fleabane	ERPL
Erigeron rusbyi	Arizona fleabane	ERRU
Erigeron speciosus	aspen fleabane	ERSP
Erigeron spp.	fleabane	ERIGER
Erigeron subtrinervis	threenerve fleabane	ERSUB
Erioganum alatum	winged buckwheat	ERAL
Eriogonum jamesii	James' buckwheat	ERJA
Eriogonum pharnaceoides	wirestem buckwheat	ERPH
Eriogonum racemosum	redroot buckwheat	ERRA
Eriagonum spp.	buckwheat	ERIOGO
Eriogonum wrightii	bastardsage	ERWR
Erysimum capitatum	sanddune wallflower	ERCA
Eupatorium herbaceum	fragrant snakeroot	EUHE
Euphorbia brachycera	horned spurge	EUBR
Euphorbia chamaesula	mountain spurge	EUCH
Euphorbia palmeri	waadland spurge	EUPA
Euphorbia revoluta	threadstem sandmat	EURE
Euphorbia spp.	warty spurge	EUPHOR
Fallugia paradoxa	Apacheplume	FAPA
Fendlera rupicola	cliff fendlerbush	FERU
Festuca arizonica	Arizona fescue	FEAR
Festuca idahoensis	Idaho fescue	FEID
Festuca sororia	ravine fescue	FESO
Festuca spp.	fescue	FESTUC
Fragaria americana	woodland strawberry	FRAM
Fragaria ovalis	Virginia strawberry	FROV
Frasera speciosa	showy frasera	FRSP
Fraxinus pennsylvanica	velvet ash	FRPE
Fraxinus spp.	ash	FRAXIN
Galactia wrightii	Wright's milkpea	GALWR
Galium aparine	stickwilly	GAAP
Galium asperrinum	Mexican bedstraw	GAASP
Galium boreale	northern bedstraw	GABO
Galium fendleri	Fendler's bedstraw	GAFE
Galium microphyllum	bracted bedstraw	GAMI
Galium rothroekii	Wright's bedstraw	GAWR
Galium spp.	bedstraw	GALIUM
Galium tinctorium	stiff marsh bedstraw	GATI
Galium triflorum	fragrant bedstraw	GATR
Galium wrightii	Wright's bedstraw	GAWR1
Garrya flavescens	ashy silktassel	GAFL
Garrya wrightii	Wright's silktassel	GAWR
Gaura gracilis	harlequinbush	GAGR
Gentiana bigelovii	pleated gentian	GEBI
Gentiana spp.	gentian	GENTIA
Gentianella amarella	autumn dwarfgentian	GEAM
Gentianella microcalyx	Chiricahua dwarfgentian	GEMI
Geranium caespitosum	pineywoods geranium	GECA
Geranium eremophilum	purple cluster geranium	GEER
Geranium richardsonii	Richardson's geranium	GERI
Geranium spp.	geranium	GERANI
Gilia aggregata	skyrocket gilia	GIAG
Gilia macombii	Macomb's skyrocket	GIMA
Gilia multiflora	many flowered gilia	GIMU

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Gilia polyantha	gilia	GIPO
Gilia spp.	gilia	GILIA
Gnaphalium arizonicum	Arizona cudweed	GNAR
Gnaphalium chilense	Wright's cudweed	GNCH
Gnaphalium macounii	winged cudweed	GNMA
Gnaphalium pringlei	western marsh cudweed	GNPR
Gnaphalium spp.	cottonbatting plant	GNAPHA
Gnaphalium wrightii	Wright's cudweed	GNWR
Goodyera oblongifolia	western rattlesnake plantain	GOOB
Gutierrezia glutinosa	Wright's snakeweed	GUGL
Gutierrezia microcephala	threadleaf snakeweed	GUMI
Habenaria hyerborea	northern green orchid	HAHY
Habenaria sparsiflora	canyon bog orchid	HASP
Haplopappus spp.	haplopappus	HAPLOP
Hedeoma dentatum	dentate falsepennyroyal	HEDE
Hedeoma diffusum	spreading falsepennyroyal	HEDI
Hedeoma hyssopifolium	falsepennyroyal	HEHY
Hedeoma oblongifolium	falsepennyroyal	HEOB
Hedeoma spp.	falsepennyroyal	HEDEOM
Hedyotis pygmaea	pygmy bluet	HEPY
Helenium hoopesii	owlsclaws	HEHO
Helianthella quinquenervis	purpledisk helianthella	HEQU
Helianthus spp.	sunflower	HELIA2
Heliopsis parvifolia	mountain oxeye	HEPA
Heracleum sphondylium	common cowparsnip	HESP
Heterotheca fulcrata	rockyscree falsegoldenaster	HEFU
Heuchera eastwoodiae	Senator Mine alumroot	HEEA
Heuchera parvifolia	littleleaf alumroot	HEUPA
Heuchera rubescens	pink alumroot	HERU
Heuchera spp.	alumroot	HEUCHE
Heuchera versicolor	pink alumroot	HEVE
Hieracium carneum	Huachuca hawkweed	HICA
Hieracium fendleri	Mogollon hawkweed	HIFE
Hieracium spp.	hawkweed	HIERAC
Holodiscus dumosus	oceanspray	HODU
Hymenopappus filifolius v. (variety) lugens	Idaho hymenopappus	NYFI
Hymenopappus mexicanus	Mexican woollywhite	HYME
Hymenothrix wrightii	Trans-Pecos thimblehead	HYWR
Hymenoxys richardsonii	pingue hymenoxys	HYRI
Hymenoxys rusbyi	Rusby's rubberweed	HYRU
Ipomoea spp.	morningglory	IPOMEA
Ipomoea coccinea	scarlet morningglory	IPCOC
Iris missouriensis	Rocky Mountain iris	IRMI
Jamesia americana	cliffbush	JAAM
Juglans major	Arizona walnut	JUMA
Juniperus communis	common juniper	JUCO
Juniperus deppeana	alligator juniper	JUDE
Juniperus monosperma	oneseed juniper	JUMO
Juniperus osteosperma	Utah juniper	JUOS
Juniperus scopulorum	Rocky Mountain juniper	JUSC
Koeleria pyramidata	prairie Junegrass	KOPY
Kuhnia rosemarinifolia	false boneset	KURO
Lathyrus arizonicus	Arizona peavine	LAAR
Lathyrus graminifolius	grassleaf peavine	LAGR
Lathyrus leucanthus	aspen peavine	LALE
Lathyrus spp.	peavine	LATHYR
Lepidium densiflorum	common pepperweed	LEDE
Lepidium medium	medium pepperweed	LEME
Lepidium spp.	pepperweed	LEPIDI
Lesquerella intermedia	mid bladderpod	LEIN
Leucelene ericoides	rose heath	LEER

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Ligularia bigelovii	Bigelow's ragwort	LIBI
Ligusticum porteri	Porter's licoriceroot	LIPO
Linum aristatum	bristle flax	LIAR
Linum lewisii	prairie flax	LILE
Linum neomexicanum	New Mexico yellow flax	LINE
Linum puberulum	plains flax	LIPU
Linum spp.	flax	LINUM
Lithospermum incisum	narrowleaf gromwell	LIIN
Lithospermum multiflorum	manyflowered gromwell	LIMU
Lithospermum spp.	gromwell	LITHOS
Lonicera albiflora	western white honeysuckle	LOAL
Lonicera arizonica	Arizona honeysuckle	LOAR
Lonicera spp.	honeysuckle	LONICE
Lonicera utahensis	Utah honeysuckle	LOUT
Lotus oroboides	New Mexico birdsfoot trefoil	LOOR
Lotus spp.	trefoil	LOTUS
Lotus wrightii	Wright's deervetch	LOWR
Lupinus argenteus	silvery lupine	LUAR
Lupinus blumeri	New Mexico lupine	LUBL
Lupinus hillii	Hill's lupine	LUHI
Lupinus kingsii	King's lupine	LUKI
Lupinus palmeri	bluebonnet lupine	LUPAL
Lupinus spp.	lupine	LUPINU
Luzula parviflora	smallflowered woodrush	LUPA
Lycurus phleoides	common wolfstail	LYPH
Machaeranthera gracilis	smallflower tansyaster	MAGR
Mahonia repens	Oregongrape	MARE
Malaxis soulei	Chiricahua addersmouth orchid	MASO
Mammillaria arizonica	Arizona spinystar	MAAR
Mammillaria spp.	nipple cactus	MAMMIL
Melilotus officinalis	yellow sweetclover	MEOF
Mertensia franciscana	Franciscan bluebells	MEFR
Mimosa biuncifera	catclaw mimosa	MIBI
Mimosa grahamii	Graham's mimosa	MIGR
Mimulus spp.	monkeyflower	MIMULU
Mirabilis pumila	dwarf four o'clock	MIPU
Monarda menthifolia	wildbergamot beebalm	MOME
Monarda pectinata	pony beebalm	MOPE
Monarda spp.	beebalm	MONARD
Moneses uniflora	single delight	MOUN
Monotropa hypopitys	pinesap	MOHY
Monotropa latisquama	pinesap	MOLA
Muhlenbergia emersleyi	bullgrass	MUEM
Muhlenbergia fragilis	delicate muhly	MUFR
Muhlenbergia glauca	desertmuhly	MUGL
Muhlenbergia longiligula	longtongue muhlly	MULO
Muhlenbergia minutissima	annual muhly	MUMI
Muhlenbergia montana	mountainmuhly	MUMO
Muhlenbergia racemosa	marsh muhly	MURA
Muhlenbergia spp.	muhly	MUHLEN
Muhlenbergia virescens	screwleaf muhly	MUVI
Nolina microcarpa	sacahuista	NOMI
Oenothera spp.	pinkladies	OENOTH
Opuntia engelmannii	cactus apple	OPEN
Opuntia plumbea	twistspine pricklypear	OPPL
Opuntia spinosior	walkingstick cactus	OPSP
Opuntia spp.	opuntia	OPUNTI
Opuntia whipplei	Whipple cholla	OPWH
Oreochrysum parryi	Parry's goldenrod	ORPA
Oryzopsis micrantha	littleseed ricegrass	ORMI
Osmorhiza chilensis	sweetcicely	OSCH

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Osmorhiza depauperata	bluntseed sweetroot	OSDE
Oxalis decaphylla	tenleaf woodsorrel	OXDE
Oxalis greyi	tenleaf woodsorrel	OXGR
Oxalis metcalfei	alpine woodsorrel	OXME
Oxalis spp.	woodsorrel	OXALIS
Oxybaphus comatus	mountain four o'clock	OXCO
Oxybaphus spp.	four o'clock	OXYBAP
Oxytropis lambertii	Lambert's crazyweed	OXLA
Pachystima myrsinites	myrtle pachistima	PAMY
Panicum bulbosum	bulb panicgrass	PABU
Panicum spp.	panicgrass	PANICU
Pedicularis grayi	giant lousewort	PEGR
Pedicularis racemosa	sickletop lousewort	PERA
Pedicularis spp.	lousewort	PEDICU
Pellaea atropurpurea	purple cliffbrake	PEAT
Pellaea spp.	cliffbrake	PALLAE
Pellaea wrightiana	Wright's cliffbrake	PEWR
Pennellia micrantha	mountain mock thelypody	PEMI
Penstemon barbatus	beardlip penstemon	PEBA
Penstemon linarioides	toadflax penstemon	PELI
Penstemon oliganthus	Apache beardtongue	PEOL
Penstemon pseudospectabilis	desert penstemon	PEPS
Penstemon spp.	beardtoungue	PENSTE
Penstemon virgatus	upright blue beardtongue	PEVI
Perezia spp.	desertpeony	PEREZI
Perityle ciliata	fringed rockdaisy	PECI
Phacelia heterophylla	varileaf phacelia	PHHE
Phacelia magellanica	Kaweah River scorpionweed	PHMA
Phacelia spp.	scorpionweed	PHACEL
Phaseolus acutifolius	tepary bean	PHAC
Phaseolus angustissimus	slimleaf bean	PHAN
Phaseolus parvulus	Pinos Altos Mountain bean	PHPA
Phaseolus spp.	bean	PHASEO
Phaseolus wrightii	slimjim bean	PHWR
Philadelphus microphyllus	littleleaf mockorange	PHMI
Phlox amabilis	Arizona phlox	PHAM
Physocarpus monogynus	mountain ninebark	PHMO
Picea engelmannii	Engelmann's spruce	PIEN
Picea pungens	blue spruce	PIPU
Pinus discolor	border pinyon	PIDI
Pinus edulis	twoneedle pinyon	PIED
Pinus engelmannii	Apache pine	PINEN
Pinus leiophylla	Chihuahuan pine	PILE
Pinus monophylla	singleleaf pinyon	PIMO
Pinus ponderosa	ponderosa pine	PIPO
Pinus strobiformis	southwestern white pine	PIST
Piptochaetium fimbriatum	pinyon ricegrass	PIFI
Plantago patagonica	woolly plantain	PLPA
Platanus wrightii	Arizona sycamore	PLWR
Plummera floribunda	Apache Pass false rubbervine	PLFL
Poa fendleriana	muttongrass	POFE
Poa pratensis	Kentucky bluegrass	POPR
Poa spp.	bluegrass	POA
Polemonium spp.	Jacobsladder	POLEMO
Polygala alba	white milkwort	POAL
Polygala longa	blue milkwort	POLO
Polygala obscura	velvetseed milkwort	POOB
Polygonum sawatchense	sawatch knotweed	POSA
Populus fremontii	Fremont's cottonwood	POFR
Populus tremuloides	quaking aspen	POTR
Potentilla hippiana	woolly cinquefoil	POHI

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Potentilla spp.	cinquefoil	POTENT
Potentilla subviscosa	Navajo cinquefoil	POSU
Potentilla thurberi	scarlet cinquefoil	POTH
Potentilla visidula	Kern cinquefoil	POVI
Prunella vulgaris	common selfheal	PRVU
Prunus emarginata	bitter cherry	PREM
Prunus serotina	black cherry	PRSE
Prunus serotina ssp. virens	black cherry	PRVI
Prunus spp.	cherry	PRUNUS
Prunus virginiana	common chokecherry	PRVI
Pseudocymopterus montanus	alpine false springparsley	PSMO
Pseudotsuga menziesii	Rocky Mountain Douglas-fir	PSME
Psoralea tenuiflora	slimflower scurfpea	PSTE
Ptelea angustifolia	common hoptree	PTAN
Pteridium aquilinum	western brackenfern	PTAQ
Pterospora andromedea	woodland pinedrops	PTAND
Pyrola chlorantha	greenflowered wintergreen	PYCH
Pyrola picta	whiteveined wintergreen	PYPI
Quercus arizonica	Arizona white oak	QUAR
Quercus chrysolepis	canyon live oak	QUCH
Quercus emoryi	Emory's oak	QUEM
Quercus gambelii	Gambel's oak	QUGA
Quercus hypoleucoides	silverleaf oak	QUHY
Quercus rugosa	netleaf oak	QURU
Quercus toumeyi	Toumey's oak	QUTO
Quercus turbinella	shrub live oak	QUTU
Ramischia secunda	sidebells wintergreen	ORSE
Rhamnus betulaefolia	beechleaf frangula	RHBE
Rhamnus californica	California buckthorn	RHCA
Rhamnus crocea	redberry buckthorn	RHCR
Rhus aromatica	skunkbush sumac	RHAR
Rhus choriophylla	evergreen sumac	RHCH
Rhus glabra	smooth sumac	RHGL
Rhus spp.	sumac	RHUS
Ribes cereum	wax currant	RICE
Ribes montigenum	gooseberry currant	RIMO
Ribes pinetorum	orange gooseberry	RIPI
Ribes spp.	ribes	RIBES
Ribes wolfii	Wolf's currant	RIWO
Robinia neomexicana	New Mexico locust	RONE
Rosa arizonica	Woods' rose	ROAR
Rosa woodsii	Woods' rose	ROWO
Rubus idaeus var. strigosus	graylea	RUID
Rubus leucodermis	whitebark raspberry	RULE
Rubus neomexicanus	New Mexico raspberry	RUNE
Rubus parviflorus	thimbleberry	RUPA
Rubus spp.	rubus	RUBUS
Salix pseudocordata	Booth's willow	SAPS
Salix scouleriana	Scouler's willow	SASC
Salix spp.	willow	SALIX
Salvia arizonica	desert indigo sage	SAAR
Salvia lemmonii	Lemmon's sage	SALE
Sambucus melanocarpa	black elderberry	SAME
Saxifraga eriophora	redfuzz saxifrage	SAER
Saxifraga spp.	saxifrage	SAXIFR
Schizachrium hirtiflorum	crimson bluestem	SCHI
Schizachyrium cirratum	Texas bluestem	SCCI
Schizachyrium scoparium	little bluestem	SCSC
Schizachyrium scoparium v.freq	little bluestem	SCSCFR
Schizachyrium scoparium v.neom	New Mexico little bluestem	SCSCNE
Scrophularia parvifolia	pineland figwort	SCPA

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Sedum griffthsii	Cockerell's stonecrop	SEDGR
Sedum spp.	stonecrop	SEDUM
Selloa glutinosa	gumhead	SEGL
Senecio bigelovii	nodding ragwort	SEBI
Senecio eremophilus	desert groundsel	SEER
Senecio multilobatus	lobeleaf groundsel	SEMU
Senecio neomexicanus	New Mexico groundsel	SENE
Senecio spartioides	broom groundsel	SESP
Senecio spp.	groundsel	SENECI
Senecio wootonii	Wooton's ragwort	SEWO
Setaria grisebachii	Grisebach's bristlegrass	SEGR
Silene laciniata	Mexican campion	SILA
Silene scouleri	Scouler's campion	SISC
Silene spp.	catchfly	SILENE
Sisymbrium linearifolium	slimleaf plainsmustard	SILI
Sitanion hystrix	bottlebrush squirreltail	SIHY
Smilacina racemosa	feathery false Solomon's seal	SMRA
Smilacina stellata	starry false Solomon's seal	SMST
Solanum tuberosum	potato	SOTU
Solidago canadensis	Canada goldenrod	SOCA
Solidago decumbens	dwarf goldenrod	SODE
Solidago missouriensis	Missouri goldenrod	SOMI
Solidago sparsiflora	threenerve goldenrod	SOSP
Solidago spp.	goldenrod	SOLIDA
Solidago wrightii	Wright's goldenrod	SOWR
Sorbus dumosa	Arizona mountainash	SODU
Sphaeralcea fendleri	Fendler's globemallow	SPFE
Sphaeralcea spp.	globemallow	SPHAER
Sporobolus interruptus	black dropseed	SPIN
Sporobolus spp.	dropseed	SPOROB
Stellaria jamesiana	tuber starwort	STJA
Stevia plummerae	Plummer's candyleaf	STPL
Stevia serrata	sawtooth candyleaf	STSE
Stevia spp.	candyleaf	STEVIA
Stipa columbiana	Dore's needlegrass	STCO
Stipa comata	needleandthread	STCOM
Stipa pringlei	Pringle's spear grass	STPR
Stipa spp.	needlegrass	STIPA
Symphoricarpos oreophilus	whortleleaf snowberry	SYOR
Symphoricarpos palmeri	Palmer's snowberry	SYPAL
Symphoricarpos parishii	Parish's snowberry	SYPAR
Symphoricarpos rotundifolius	roundleaf snowberry	SYRO
Taraxacum officinale	common dandelion	TAOF
Thalictrum fendleri	Fendler's meadowrue	THFE
Thelesperma megapotamicum	Hopi tea greenthread	THME
Thelypodium longifolium	longleaf mock thelypody	THLO
Thelypodium spp.	thelypody	THELYP
Thelypodium wrightii	Wright's thelypody	THWR
Thermopsis pinetorum	mountain thelypody	THPI
Thlaspi fendleri	Fendler's pennycress	THLFE
Townsendia eximia	tall townsendia	TOEX
Townsendia exscapa	stemless townsendia	TOEXS
Toxicodendron rydbergii	western poison ivy	TORY
Tradescantia pinetorum	pinewoods spiderwort	TRAPI
Tragia ramosa	branched noseburn	TRRA
Tragopogon pratensis	meadow salsify	TRAPR
Trisetum spicatum v. montanum	spike trisetum	TRSP
Trifolium pinetorum	woods clover	TRIPI
Trifolium spp.	clover	TRIFOL
Vaccinium myrtillus	whortleberry	VAMY
Valeriana acutiloba	sharpleaf valerian	VAAC

APPENDIX A (continued)

Scientific Name	Common Name	HT Acronym
Valeriana arizonica	Arizona valerian	VAAR
Valeriana spp.	valerian	VALERI
Verbascum thapsus	common mullein	VETH
Verbena bipinnatifida	Dakota mock vervain	VEBI
Verbena spp.	verbena	VERBEN
Verbesina longifolia	longleaf crownbeard	VELO
Vicia americana	American vetch	VIAM
Vicia pulchella	sweetclover vetch	VIPU
Vicia spp.	vetch	VICIA
Vicia villosa	winter vetch	VIVI
Vigulera annua	longleaf falsegoldeneye	VIAN
Vigulera dentata	toothleaf goldeneye	VIDE
Vigulera multiflora	showy goldeneye	VIMU
Viola canadensis	Canadian white viole	VICA
Vitis arizonica	toothleaf goldeneye	VIAR
Woodsia mexicana	Mexican woodsia	WOME
Woodsia spp.	woodsia	WOODSI
Yucca baccata	banana yucca	YUBA
Yucca schottii	Schott's yucca	YUSC
Yucca spp.	yucca	YUCCA

APPENDIX B

Average density and percent constancy of major tree species, and average percent cover and constancy of the shrub, grass and forb species within each habitat type in southern Arizona and portions of the Colorado Plateau.

In these summary association tables, tree sizes are defined as:

Yng. regen. = trees less than 2 inches (5cm) diameter breast height
Adv. regen. = trees 2-10 inches (5-25 cn) diameter breast height
Mature = trees larger than 10 inches (25 cm) diameter breast height

Table 1. Species average density (D) or cover (C) and constancy (CON) for the Abies lasiocarpa and Picea engelmannii series.

Type No. 1 =Picea engelmannii/Moss HT
Type No. 2 =Picea engelmannii/Carex foenea HT
Type No. 3 =Picea engelmannii/Acer glabrum HT
Type No. 4 =Picea engelmannii/Erigeron eximius HT
Type No. 5 =Abies lasiocarpa/Moss HT
Type No. 6 =Abies lasiocarpa/Vaccinium myrtillus HT
Type No. 7 =Abies lasiocarpa/Vaccinium myrtillus - Rubus parviflorus HT
Type No. 8 =Abies lasiocarpa/Rubus parviflorus HT
Type No. 9 =Abies lasiocarpa/Erigeron eximius HT
Type No.10 =Abies lasiocarpa/Jamesia americana HT

Type No:	1		2		3		4		5	
No. Plots:	(1)		(2)		(4)		(2)		(2)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Abies concolor (yng. regen.)					16	100	8	50		
Abies concolor (adv. regen.)					1	25				
Abies concolor (mature)					2	75				
Abies lasiocarpa (yng. regen.)			1	50					8	100
Abies lasiocarpa (adv. regen.)	2	100							10	100
Abies lasiocarpa (mature)									7	50
Picea engelmannii (yng. regen)	12	100	11	100	27	100	45	100	21	100
Picea engelmannii (adv. regen)	39	100	8	100	6	100	38	50	22	100
Picea engelmannii (mature)	25	100	9	100	6	100	2	100	4	100
Picea pungens (y. regen)							17	50		
Picea pungens (a. regen)							16	50		
Picea pungens (mature)							2	50		
Pinus ponderosa (adv. regen.)							1	50		
Pinus ponderosa (mature)							1	100		
Pinus strobiformis (yng. reg.)					16	50	4	100		
Pinus strobiformis (adv. reg.)					4	25	1	100		
Pinus strobiformis (mature)					1	25				
Populus tremuloides (y. reg.)							60	50		
Populus tremuloides (a. reg.)					5	50	10	50		
Populus tremuloides (mature)					8	75				
Pseudotsuga menziesii (y. reg)					23	100	34	100	2	50
Pseudotsuga menziesii (a. reg)					3	50	14	100		
Pseudotsuga menziesii (mature)					4	100	6	100	1	50
SHRUBS										
Acer glabrum						11	100			
Alnus tenuifolia								6	50	
Amelanchier mormonica								<1	50	

APPENDIX B: Table 1 (continued)

Type No:	1		2		3		4		5	
No. Plots:	(1)		(2)		(4)		(2)		(2)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Holodiscus dumosus						<1	25			
Jamesia americana										
Lonicera arizonica						<1	25			
Lonicera utahensis	<1	100					<1	50		
Pachystima myrsinites							7	50		
Physocarpus monogynus					<1	25				
Populus tremuloides					<1	75	<1	50	<1	50
Ribes spp.										
Ribes montigenum	<1	100	<1	50						
Ribes pinetotorum										
Ribes wolfii										
Robinia neomexicana							<1	50		
Rubus idaeus var. strigosus										
Rubus leucodermis										
Rubus parviflorus							1	50		
Rubus spp.										
Sambucus melancarpa										
Vaccinium myrtilus						2	25		<1	50
GRAMINOIDS										
Agrostis idahoensis							<1	50		
Bromopsis richardsonii			<1	100	<1	50	6	100	<1	50
Bromopsis porteri					<1	25				
Carex spp.									<1	100
Carex bella										
Carex foenea			37	100			7	100		
Carex geophila										
Carex rossii										
Festuca idahoensis	<1	100								
Festuca sororia			<1	100	4	25				
Koeleria pyramidata							<1	50		
Luzula parviflora										
Poa fendleriana			<1	50						
Poa pratensis			4	50						
Tresetum spicatum v. montanum										
FORBS										
Achillea millefolium							<1	100		
Actea argut										
Aquilegia spp.							<1	50		
Arenaria spp.			<1	50						
Besseya plantaginea							<1	100		
Campanula rotundifolia			<1	100						
Chimiphila umbellata					<1	25				
Cystopteris fragilis					<1	25				
Epilobium angustifolium	<1	100								
Erigeron spp.			<1	50						
Erigeron eximius	<1	100			<1	25	10	50		
Erigeron subtrinervis									<1	50
Fragaria americana					<1	25	4	100		
Fragaria ovalis			<1	50						
Galium spp.							<1	50		
Galium triflorum										
Gentianella amarella							<1	50		
Geranium richardsonii			<1	50	<1	25	4	100		
Goodyera obiongifolia					<1	50	<1	50		
Habenaria hyerborea										
Helenium hoopesii										
Lathyrus arizonicus			<1	100	<1	25	<1	100		

APPENDIX B: Table 1 (continued)

	Type No:	1		2		3		4		5	
	No. Plots:	(1)		(2)		(4)		(2)		(2)	
		D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Ligularia bigelovii				<1	50	<1	50				
Ligusticum porteri		<1	100			<1	75	<1	50		
Mertensia franciscana				<1	100						
Moneses uniflora											
Oreochrysum parryi				<1	100						
Ramischia secunda											
Osmorhiza depauperata								<1	50		
Pedicularis racemosa											
Penstemon spp											
Potentilla subviscosa				<1	50					<1	50
Pseudocymopterus montanus				<1	50	<1	75	<1	100		
Pteridium aquilinum						1	75	<1	100		
Pyrola chlorantha						<1	25	<1	50		
Pyrola picta											
Senecio eremophilus											
Senecio spp.											
Senecio wootoni				<1	50			3	100	<1	50
Smilacina racemosa						<1	50	<1	50		
Smilacina stellata						<1	25	1	100		
Taraxacum officinale								<1	50		
Thalictrum fendleri						<1	25	1	100		
Vicia americana				<1	100	<1	50	<1	100		
Vicia pulchella				<1	50						
Viola canadensis						<1	50	<1	50		
Woodsia spp											
TREES											
Abies concolor (yng. regen.)											
Abies concolor (adv. regen.)											
Abies concolor (mature)											
Abies lasiocarpa (yng. regen.)		43	100	>100	100	>100	100	31	100	4	100
Abies lasiocarpa (adv. regen.)		10	100	5	100	12	100	11	100	7	100
Abies lasiocarpa (mature)		4	67	2	100	7	100	3	100	4	100
Picea engelmannii (yng. regen)		32	100	57	100	51	100	22	100		
Picea engelmannii (adv. regen)		22	100	18	100	13	100	18	100		
Picea engelmannii (mature)		17	100	11	100	6	100	13	100		
Picea pungens (y. regen)											
Picea pungens (a. regen)											
Picea pungens (mature)											
Pinus ponderosa (adv. regen.)											
Pinus ponderosa (mature)											
Pinus strobiformis (yng. reg.)											
Pinus strobiformis (adv. reg.)											
Pinus strobiformis (mature)											
Populus tremuloides (y. reg.)										11	100
Populus tremuloides (a. reg.)								2	50	1	100
Populus tremuloides (mature)								3	50	1	100
Pseudotsuga menziesii (y. reg)								2	50		
Pseudotsuga menziesii (a. reg)											
Pseudotsuga menziesii (mature)								1	50	4	100
SHRUBS											
Acer glabrum				<1	100	<1	100				
Alnus tenuifolia											
Amelanchier mormonica											
Holodiscus dumosus											
Jamesia americana										10	100
Lonicera arizonica											
Lonicera utahensis		<1	100	<1	100	3	100	1	50		

APPENDIX B: Table 1 (continued)

	Type No:	1		2		3		4		5	
	No. Plots:	(1)		(2)		(4)		(2)		(2)	
		D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Pachystima myrsinites											
Physocarpus monogynus											
Populus tremuloides		<1	33					<1	50		
Ribes spp.								1	50		
Ribes montigenum								2	50		
Ribes pinetotorum										10	100
Ribes wolfii								<1	50		
Robinia neomexicana											
Rubus idaeus var. strigosus											
Rubus leucodermis						1	100				
Rubus parviflorus				5	100	20	100	<1	50		
Rubus spp.										30	100
Sambucus melancarpa										5	100
Vaccinium myrtillus		33	67	10	100	<1	100	5	50		
GRAMINOIDS											
Agrostis idahoensis											
Bromopsis richardsonii		<1	100	<1	100	1	100	<1	100		
Bromopsis porteri											
Carex spp.		<1	67			<1	100				
Carex bella		<1	33								
Carex foenea											
Carex geophila								<1	50		
Carex rossii		<1	33								
Festuca idahoensis				<1	100						
Festuca sororia		<1	33								
Koeleria pyramidata		<1	33								
Luzula parviflora		<1	33					<1	50		
Poa fendleriana											
Poa pratensis											
Tresetum spicatum v. montanum				<1	100			<1	50		
FORBS											
Achillea millefolium		<1	33								
Actea arguta				<1	100	3	100				
Aquilegia spp.				<1	100	<1	100			1	100
Arenaria spp.											
Besseya plantaginea											
Campanula rotundifolia											
Chimiphila umbellata											
Cystopteris fragilis											
Epilobium angustifolium						2	100				
Erigeron spp.											
Erigeron eximius				1	100	2	100	20	100		
Erigeron subtrinervis											
Fragaria americana		<1	67					1	50		
Fragaria ovalis				2	100	<1	100	<1	50		
Gallum spp.										<1	100
Gallum triflorum						<1	100				
Gentianella amarella											
Geranium richardsonii				<1	100	4	100	<1	50		
Goodyera oblongifolia						<1	100	<1	50		
Habenaria hyerborea								<1	50		
Helenium hoopesii								<1	50		
Lathyrus arizonicus		<1	67	<1	100	<1	100	1	50		
Ligularia bigelovii											
Ligusticum porteri		<1	33	<1	100	<1	100	5	50		
Mertensia franciscana								<1	50		
Moneses uniflora		<1	33								

APPENDIX B: Table 1 (continued)

Type No:	1		2		3		4		5	
No. Plots:	(1)		(2)		(4)		(2)		(2)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Oreochrysum parryi	<1	67	<1	100			<1	50		
Ramischia secunda	<1	100	<1	100	<1	100	<1	50		
Osmorhiza depauperata	<1	67	<1	100	1	100	<1	100		
Pedicularis racemosa	<1	33					<1	50		
Penstemon spp.							<1	50		
Potentilla subviscosa										
Pseudocymopterus montanus	<1	67			<1	100	<1	100		
Pteridium aquilinum							<1	50	2	100
Pyrola chlorantha	<1	33								
Pyrola picta			<1	100			<1	50		
Senecio eremophilus							<1	50		
Senecio spp.									<1	100
Senecio wootoni										
Smilacina racemosa					<1	100	<1	50		
Smilacina stellata	<1	67			<1	100	1	50		
Taraxacum officinale										
Thalictrum fendleri			<1	100	2	100				
Vicia americana	<1	67							20	100
Vicia pulchella										
Viola canadensis			<1	100	1	100	<1	50		
Woodsia spp.									<1	100

Table 2. Species average density (D) or cover (C) and constancy (CON) for the Picea pungens, Abies concolor, and Pseudotsuga menziesii series.

Type No. 11=Picea pungens/festuca arizonica HT
Type No. 12=Picea pungens/psedutsuga menziesii HT juniperus communis PH
Type No. 13=Picea pungens/erigeron eximius HT
Type No. 14=Abies concolor/vaccinium myrtillus HT
Type No. 15=Abies concolor/carex foenea HT
Type No. 16=Abies concolor/berberis repens HT
Type No. 17=Abies concolor/acer glabrum HT
Type No. 19=Abies concolor/erigeron eximius HT valeriana arizonica PH
Type No. 18=Abies concolor/quercus gambelii HT
Type No. 20=Abies concolor/acer grandidentatum HT
Type No. 21=Abies concolor/juglans major HT
Type No. 24=Pseudotsuga menziesii/sparse
Type No. 22=Pseudotsuga menziesii/muhlenbergia virescens HT
Type No. 23=Pseudotsuga menziesii/muhlenbergia montana HT
Type No. 25=Pseudotsuga menziesii/quercus gambelii HT
Type No. 26=Pseudotsuga menziesii/acer grandidentatum HT
Type No. 27=Pseudotsuga menziesii/quercus rugosa HT
Type No. 28=Pseudotsuga menziesii/quercus hypoleucoides HT
Type No. 29=Pseudotsuga menziesii/quercus arizonica HT

Type No:	11		12		13		14		15	
No. Plots:	(2)		(1)		(1)		(1)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Abies concolor (yng. regen.)			5	100	20	100	14	100		
Abies concolor (adv. regen.)							20	100	4	67
Abies concolor (mature)									2	67
Abies lasiocarpa (yng. regen.)	3	50							2	33
Acer glabrum (yng. regen.)							10	100	2	33
Acer glabrum (adv. regen.)										
Acer glabrum (mature)										
Acer grandidentatum (y.regen.)										
Acer grandidentatum (a.regen.)										
Acer grandidentatum (mature)										
Acer negundo (y regen)										
Acer negundo (mature)										
Arbutus arizonica (y. regen.)										
Arbutus arizonica (a. regen.)										
Fraxinus pennsylvanica (y.reg)										
Fraxinus pennsylvanica (a.reg)										
Juglans major (yng. regen.)										
Juglans major (adv.regen.)										
Juglans major (mature)										
Juniperus deppeana (y. regen.)										
Juniperus deppeana (a. regen.)										
Juniperus deppeana (mature)										
Juniperus scopulorum (y. rg.)										
Picea engelmannii (yng. regen)	9	50	4	100					1	33
Picea engelmannii (adv. regen)	11	50			1	100				
Picea engelmannii (mature)	1	50							1	33
Picea pungens (y. regen)	20	100	36	100	19	100				
Picea pungens (a. regen)	18	100	3	100	24	100				
Picea pungens (mature)	6	100			5	100				
Pinus discolor (yng. regen.)										
Pinus discolor (adv. regen.)										
Pinus edulis (yng. regen.)										
Pinus engelmannii (adv. regen)										
Pinus engelmannii (mature)										
Pinus ponderosa (yng. regen.)	1	50					1	100	6	33
Pinus ponderosa (adv. regen.)	4	50								

APPENDIX B: Table 2 (continued)

Type No: / No. Plots:	11 (2)		12 (1)		13 (1)		14 (1)		15 (3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Pinus ponderosa (mature)	4	50								
Pinus strobiformis (yng. reg.)	6	50	26	100			>100	100	7	67
Pinus strobiformis (adv. reg.)	8	50	3	100			13	100	8	100
Pinus strobiformis (mature)	1	50	3	100			1	100	3	67
Populus tremuloides (y. reg.)	19	100	14	100					1	33
Populus tremuloides (a. reg.)	1	100	6	67						
Populus tremuloides (mature)	1	50	1	33						
Prunus serotina (yng. reg.)										
Prunus serotina (adv. reg.)										
Prunus serotina (mature)										
Pseudotsuga menziesii (y. reg)	18	50	>100	100	19	100	>100	100	11	100
Pseudotsuga menziesii (a. reg)	15	50	24	100	25	100	24	100	6	67
Pseudotsuga menziesii (mature)	2	50	11	100	6	100	4	100	2	100
Quercus arizonica (y. regen.)										
Quercus arizonica (a. regen.)										
Quercus arizonica (mature)										
Quercus chrysolepis (y. reg.)										
Quercus chrysolepis (a. reg.)										
Quercus chrysolepis (mature)										
Quercus emoryi (y. regen.)										
Quercus emoryi (a. regen.)										
Quercus gambelii (y. regen.)							4	100		
Quercus gambelii (a. regen.)							2	100		
Quercus gambelii (mature)										
Quercus hypoleucoides (y.reg.)										
Quercus hypoleucoides (a.reg.)										
Quercus hypoleucoides (mature)										
Quercus rugosa (y. regen.)										
Quercus rugosa (a. regen.)										
SHRUBS										
Acer glabrum							6	100	8	33
Acer grandidentatum										
Acer negundo										
Agave spp.										
Agave parryi										
Amelanchier utahensis			<1	100						
Amorpha fruticosa										
Arbutus arizonica										
Arctostaphylos pringlei										
Baccharis thesioides										
Brickellia californica										
Ceanothus fendleri										
Cercocarpus montanus										
Clematis columbiana										
Fendlera rupicola										
Fraxinus spp.										
Fraxinus pennsylvanica										
Garrya wrightii										
Holodiscus dumosus									<1	33
Jamesia americana										
Juglans major										
Juniperus communis			25	100	<1	100				
Juniperus deppeana (shrubs)										
Lonicera spp.					<1	100				
Lonicera albiflora										
Lonicera arizonica			<1	100						
Lonicera involcrata										
Lonicera utahensis										

APPENDIX B: Table 2 (continued)

Type No: / No. Plots:	11 (2)		12 (1)		13 (1)		14 (1)		15 (3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Berberis repens							1	100		
Nolina microcarpa										
Pachystima myrsinites							4	100		
Philadelphus microphyllus										
Populus tremuloides	2	100	<1	100					<1	67
Prunus spp.										
Prunus emarginata										
Prunus serotina ssp. virens	<1	50								
Ptelea angustifolia										
Quercus arizonica										
Quercus chrysolepis										
Quercus emoryi										
Quercus gambelii							2	100		
Quercus hypoleucoides										
Quercus rugosa										
Rhamnus betulaefolia										
Rhamnus californica										
Rhus aromatica										
Rhus choriophylla										
Rhus glabra							1	100		
Ribes pinetotorum					<1	100			<1	33
Robinia neomexicana							<1	100		
Rosa arizonica										
Rosa woodsii	<1	50	<1	100			<1	100		
Rubus idaeus var. strigosus										
Rubus leucodermis			<1	100	2	100				
Rubus neomexicanus										
Rubus parviflorus			<1	100	2	100	2	100		
Salix scouleriana										
Sambucus melancarpa										
Sorbus dumosa										
Symphoricarpos oreophilus										
Symphoricarpos palmeri										
Toxicodendron rydbergii										
Vaccinium myrtillus							40	100		
Vitis arizonica										
Yucca baccata										
Yucca schottii										
GRAMINOIDS										
Agropyron arizonicum									2	33
Agropyron subsecundum										
Aristida spp.										
Aristida orcuttiana										
Blepharoneuron tricholepis	<1	50								
Bromus spp.										
Bromopsis richardsonii	<1	100	<1	100	<1	100	<1	100	13	100
Bromopsis porteri										
Carex spp.										
Carex brevipes										
Carex geophila										
Carex rossii									<1	67
Cyperus fendlerianus										
Carex foenea	6	100	<1	100	20	100			70	100
Dactylis glomerata										
Festuca spp.										
Festuca arizonica	25	100	<1	100	<1	100			1	33
Festuca sororia									<1	33
Koeleria pyramidata										

APPENDIX B: Table 2 (continued)

Type No:	11		12		13		14		15	
No. Plots:	(2)		(1)		(1)		(1)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Muhlenbergia longiligula										
Muhlenbergia montana			<1	100					<1	33
Muhlenbergia virescens	<1	100					<1	100		
Panicum bulbosum										
Piptochaetium fimbriatum										
Poa fendleriana									<1	33
Poa pratensis	<1	50							5	67
Sitanion hystrix										
Stipa pringlei										
Tresetum spicatum v. montanum					1	100				
FORBS										
Achillea millefolium	<1	50			<1	100			2	33
Actea arguta			<1	100	<1	100				
Agastache sp.										
Allium spp										
Allium cernuum										
Androsace septentrionalis										
Antennaria spp.										
Antennaria arida										
Antennaria neglecta										
Antennaria parvifolia							3	100		
Anthericum torreyi										
Aquilegia spp.	<1	100	<1	100			<1	33		
Aquilegia elegantula										
Aquilegia chrysantha									<1	33
Arabis spp.										
Arenaria spp.									<1	33
Arenaria lanuginosa	<1	50								
Artemisia carruthii										
Artemisia ludoviciana										
Astragulus spp										
Bahia dissecta										
Besseya plantaginea					1	100				
Bidens spp.										
Bidens lemmonii										
Brickellia spp.										
Brickellia betonieaefolia										
Brickellia brachyphylla										
Brickellia grandiflora										
Cacalia decomposita										
Campanula rotundifolia									1	67
Castilleja spp										
Castilleja austromontana			<1	100						
Castilleja confusa							<1	100		
Castilleja integra										
Cerastium nutans					<1	100				
Chaptalia alsophila										
Cheilanthes fendleri										
Chenopodium spp.										
Chenopodium fremontii										
Chimiphila menziesii							2	100		
Chimiphila umbellata										
Cirsium spp.										
Cirsium parryi					<1	100				
Cirsium rothrockii										
Cirsium wheeleri										
Cirsium wrightii	<1	50								
Cologania longifolia										

APPENDIX B: Table 2 (continued)

Type No:	11		12		13		14		15	
No. Plots:	(2)		(1)		(1)		(1)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Comandra umbellata s. pallida										
Conyza schiedeana										
Corallorhiza spp.										
Corallorhiza striata										
Cosmos spp.										
Cystopteris fragilis										
Desmodium sp.										
Draba sp.										
Draba helleriana										
Epilobium angustifolium					<1	100				
Erigeron spp.									<1	33
Erigeron caespitosus										
Erigeron eximius			3	100	10	100				
Erigeron formosissimus	7	50							1	33
Erigeron neomexicanus										
Erigeron oreophilus										
Erigeron platyphyllus										
Erigeron rusbyi										
Erigeron speciosus										
Erigeron subtrinervis										
Eriogonum spp.										
Eupatorium herbaceum										
Euphorbia spp.			<1	100						
Euphorbia brachycera										
Euphorbia chamaesula										
Fragaria americana									<1	33
Fragaria ovalis	<1	100	<1	100	1	100	<1	100	<1	67
Galium spp.										
Galium apparine										
Galium asperrimum										
Galium boreale										
Galium fendleri										
Galium microphyllum										
Galium rothroekii										
Galium tinctorium										
Galium triflorum					<1	100			<1	33
Gentiana bigelovii										
Geranium spp.										
Geranium caespitosum										
Geranium ereophilum										
Geranium richardsonii			<1	100	4	100	2	100	2	100
Gilia aggregata										
Gilia multiflora										
Gilia spp.										
Gnaphalium spp										
Gnaphalium macounii										
Goodyera oblongifolia										
Haploppappus spp.										
Hedeoma spp.										
Hedeoma diffusum										
Hedeoma hyssopifolium										
Hedeoma oblongifolium										
Helenium hoopesii					<1	100			<1	67
Heracleum sphondylium										
Hellanthella quinquenervis					<1	100				
Heuchera spp										
Heuchera eastwoodiae										
Heuchera parvifolia										
Heuchera versicolor										

APPENDIX B: Table 2 (continued)

Type No:	11		12		13		14		15	
No. Plots:	(2)		(1)		(1)		(1)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Hieracium carneum										
Hieracium fendleri									<1	33
Hymenopappus mexicanus										
Iris missouriensis	<1	50								
Lathyrus spp.									<1	33
Lathyrus arizonicus	<1	50	15	100			<1	100	<1	67
Lathyrus graminifolius										
Lathyrus leucanthus										
Ligusticum porteri			<1	100	<1	100				
Linum neomexicanum										
Lithosperum multiflorum	<1	100								
Lithosperum spp.										
Lotus wrightii										
Lupinus spp.										
Lupinus hillii										
Malaxis soulei										
Monarda menthafolia										
Monotropa latisquama										
Oenothera spp.										
Oreochrysum parryi			2	100						
Osmorhiza chilensis										
Osmorhiza depauperata										
Oxalis spp.									<1	33
Oxalis decaphylla										
Oxalis metcalfei										
Oxybaphus spp.										
Oxybaphus comatus										
Pelleae spp										
Penstemon spp										
Penstemom barbatus										
Penstemon virgatus										
Perityle ciliata										
Phacelia spp										
Phaseolus spp.										
Phaseolus parvulus										
Potentilla spp.									<1	33
Potentilla hippiana	<1	50			<1	100				
Potentilla thurberi										
Potentilla visidula										
Prunella vulgaris					<1	100				
Pseudocymopterus montanus	<1	50			<1	100	<1	100	<1	67
Pteridium aquilinum			1	100					3	67
Pyrola chlorantha									<1	33
Pyrola picta					<1	100				
Salvia arizonica										
Saxifraga							<1	100		
Scrophularia parvifolia										
Senecio bigelovii					<1	100				
Senecio eremophilus										
Senecio neomexicanus										
Senecio spartiodes										
Senecio wootoni	2	50	2	100	3	100	<1	100	3	67
Silene spp.										
Silene laciniata										
Silene scouleri									<1	33
Sisymbrium linearifolium										
Smilacina racemosa			<1	100	<1	100	<1	100		
Smilacina stellata			<1	100	2	100	<1	100	<1	33
Solidago decumbens	<1	50								

APPENDIX B: Table 2 (continued)

Type No: / No. Plots:	11 (2)		12 (1)		13 (1)		14 (1)		15 (3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Solidago spp.										
Solidago sparsiflora										
Solidago wrightii										
Stevia spp.										
Stevia plummerae										
Stevia serrata										
Thalictrum fendleri	<1	50			<1	100	<1	100	2	67
Thelypodium spp										
Thelypodium wrightii										
Thermopsis pinetorum										
Thlaspi fendleri										
Tragia ramosa										
Valeriana spp										
Valeriana arizonica										
Verbena bipinnatifida										
Verbesina longifolia										
Vicia spp.									2	33
Vicia americana	<1	50			<1	100	<1	100	<1	33
Vicia pulchella										
Viguiera multiflora										
Viola canadensis			<1	100	<1	100	<1	100		
Woodsia mexicana										

Type No: / No. Plots:	16 (7)		17 (5)		19 (2)		18 (8)		20 (5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Abies concolor (yng. regen.)	33	100	19	100	>100	100	85	100	51	100
Abies concolor (adv. regen.)	8	100	9	100	15	100	16	100	7	100
Abies concolor (mature)	4	71	5	80	5	100	5	100	5	80
Abies lasiocarpa (yng. regen.)			2	20						
Acer glabrum (yng. regen.)			3	40	1	50				
Acer glabrum (adv. regen.)			4	40						
Acer glabrum (mature)			1	20						
Acer grandidentatum (y.regen.)				3	50	1	13	44	80	
Acer grandidentatum (a.regen.)									9	100
Acer grandidentatum (mature)									2	60
Acer negundo (y regen)					1	50				
Acer negundo (mature)										
Arbutus arizonica (y. regen.)										
Arbutus arizonica (a. regen.)										
Fraxinus pennsylvanica (y.reg)										
Fraxinus pennsylvanica (a.reg)										
Juglans major (yng. regen.)							1	20		
Juglans major (adv.regen.)							1	13	1	20
Juglans major (mature)										
Juniperus deppeana (y. regen.)							3	13		
Juniperus deppeana (a. regen.)							2	25		
Juniperus deppeana (mature)										
Juniperus scopulorum (y. rg.)							1	13		
Picea engelmannii (yng. regen)										
Picea engelmannii (adv. regen)										
Picea engelmannii (mature)										
Picea pungens (y. regen)										
Picea pungens (a. regen)										
Picea pungens (mature)										
Pinus discolor (yng. regen.)							1	13		
Pinus discolor (adv. regen.)										

APPENDIX B: Table 2 (continued)

Type No:	16		17		19		18		20	
No. Plots:	(7)		(5)		(2)		(8)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Pinus edulis (yng. regen.)										
Pinus engelmannii (adv. regen)										
Pinus engelmannii (mature)										
Pinus ponderosa (yng. regen.)	1	29			3	50	5	50	2	40
Pinus ponderosa (adv. regen.)	2	38								
Pinus ponderosa (mature)	1	14					2	38		
Pinus strobiformis (yng. reg.)	9	71	2	100	98	50	6	25	32	20
Pinus strobiformis (adv. reg.)	6	71	2	80	12	50	2	13	8	20
Pinus strobiformis (mature)	3	57	2	60	1	50	1	13	2	40
Populus tremuloides (y. reg.)	3	14	14	40			6	13	1	40
Populus tremuloides (a. reg.)	4	29	5	40			3	13		
Populus tremuloides (mature)	2	40					1	20		
Prunus serotina (yng. reg.)										
Prunus serotina (adv. reg.)										
Prunus serotina (mature)										
Pseudotsuga menziesii (y. reg)	23	100	6	80	>100	100	14	88	98	60
Pseudotsuga menziesii (a. reg)	9	100	1	40	13	100	8	88	7	80
Pseudotsuga menziesii (mature)	6	86	5	100	4	100	5	88	4	80
Quercus arizonica (y. regen.)										
Quercus arizonica (a. regen.)										
Quercus arizonica (mature)										
Quercus chrysolepis (y. reg.)										
Quercus chrysolepis (a. reg.)										
Quercus chrysolepis (mature)										
Quercus emoryi (y. regen.)										
Quercus emoryi (a. regen.)										
Quercus gambelii (y. regen.)					14	50	13	50	9	60
Quercus gambelii (a. regen.)					1	50	8	75	4	80
Quercus gambelii (mature)					1	50	4	63	2	20
Quercus hypoleucoides (y.reg.)										
Quercus hypoleucoides (a.reg.)							1	13		
Quercus hypoleucoides (mature)										
Quercus rugosa (y. regen.)	1	14								
Quercus rugosa (a. regen.)										
SHRUBS										
Acer glabrum			15	100	<1	50				
Acer grandidentatum					1	50	<1	25	42	100
Acer negundo					<1	50				
Agave spp.										
Agave parryi										
Amelanchier utahensis										
Amorpha fruticosa										
Arbutus arizonica										
Arctostaphylos pringlei										
Baccharis thesioides										
Brickellia californica										
Ceanothus fendleri										
Cercocarpus montanus							<1	13		
Clematis columbiana										
Fendlera rupicola										
Fraxinus spp.										
Fraxinus pennsylvanica									<1	20
Garrya wrightii										
Holodiscus dumosus	<1	14	1	20			<1	13		
Jamesia americana	2	14	5	20						
Juglans major									2	40
Juniperus communis										
Juniperus deppeana (shrubs)							<1	13		

APPENDIX B: Table 2 (continued)

Type No:	16		17		19		18		20	
No. Plots:	(7)		(5)		(2)		(8)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Lonicera spp.									<1	20
Lonicera albiflora										
Lonicera arizonica	<1	14			15	50	3	38		
Lonicera involcrata										
Lonicera utahensis										
Berberis repens					<1	100	2	38	1	20
Nolina microcarpa										
Pachystima myrsinites					3	100	5	20		
Philadelphus microphyllus			<1	20						
Populus tremuloides	<1	29	2	60			<1	13	<1	20
Prunus spp.										
Prunus emarginata							1	13		
Prunus serotina ssp. virens							<1	13		
Ptelea angustifolia							10	13		
Quercus arizonica										
Quercus chrysolepis										
Quercus emoryi										
Quercus gambelii					3	100	17	100	5	100
Quercus hypoleucoides							8	13		
Quercus rugosa	<1	14					<1	13		
Rhamnus betulaefolia	1	13	1	20						
Rhamnus californica										
Rhus aromatica					<1	50	1	38		
Rhus choriophylla										
Rhus glabra										
Ribes pinetotorum			<1	40			<1	13		
Robinia neomexicana	<1	14	<1	20	<1	100	2	75	2	60
Rosa arizonica					<1	50	<1	20		
Rosa woodsii	<1	13								
Rubus idaeus var. strigosus			<1	14	<1	20				
Rubus leucodermis					<1	50	<1	40		
Rubus neomexicanus										
Rubus parviflorus					10	50	<1	13	2	20
Salix scouleriana			3	40			<1	13		
Sambucus melancarpa			<1	20			<1	50		
Sorbus dumosa										
Symphoricarpos oreophilus	<1	14	2	40			<1	38	1	20
Symphoricarpos palmeri										
Toxicodendron rydbergii					<1	50	<1	13		
Vaccinium myrtillus										
Vitis arizonica										
Yucca baccata							1	13		
Yucca schottii										
GRAMINOIDS										
Agropyron crizonicum										
Agropyron subsecundum										
Aristida spp.										
Aristida orcuttiana										
Blepharoneuron tricholepis										
Bromus spp.	<1	14					1	13		
Bromopsis richardsonii	2	71	3	100	3	100	<1	88	3	80
Bromopsis porteri										
Carex spp.			<1	20			1	13		
Carex brevipes	<1	29	<1	20			10	13		
Carex geophila	3	14			<1	13				
Carex rossii	<1	43	<1	20						
Cyperus fendlerianus										
Carex foenea			7	60			1	38	3	80

APPENDIX B: Table 2 (continued)

Type No:	16		17		19		18		20	
No. Plots:	(7)		(5)		(2)		(8)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Dactylis glomerata										
Festuca spp.			1	40						
Festuca arizonica	<1	14								
Festuca sororia										
Koeleria pyramidata	<1	71	<1	20	4	50	1	50	5	20
Muhlenbergia longiligula										
Muhlenbergia montana	<1	29								
Muhlenbergia virescens							<1	13		
Panicum bulbosum					1	50	5	25		
Piptochaetium fimbriatum										
Poa fendleriana	<1	29	<1	40	<1	50	2	25		
Poa pratensis	<1	20								
Sitanion hystrix							<1	38		
Stipa pringlei										
Tresetum spicatum v. montanum										
FORBS										
Achillea millefolium							1	13	<1	20
Actea arguta										
Agastache sp.							<1	13		
Allium spp										
Allium cernuum			<1	20						
Androsace septentrionalis							<1	13		
Antennaria spp.	<1	14								
Antennaria arida										
Antennaria neglecta					2	50	<1	13	<1	20
Antennaria parvifolia					<1	50				
Anthericum torreyi										
Aquilegia spp.			5	20						
Aquilegia elegantula			<1	20						
Aquilegia chrysantha										
Arabis spp.										
Arenaria spp.	<1	43	<1	40						
Arenaria lanuginosa			<1	20			<1	13	<1	20
Artemisia carruthii										
Artemisia ludoviciana					<1	50				
Astragulus spp.							<1	13		
Bahia dissecta										
Besseya plantaginea					<1	50			<1	20
Bidens spp.							<1	13		
Bidens lemmonii										
Brickellia spp.										
Brickellia betonieaefolia									<1	20
Brickellia brachyphylla										
Brickellia grandiflora	<1	14					<1	25		
Cacalia decomposita										
Campanula rotundifolia			<1	20						
Castilleja spp.									<1	20
Castilleja austromontana							<1	50		
Castilleja confusa										
Castilleja integra										
Cerastium nutans										
Chaptalia alsophila										
Chellanthes fendleri										
Chenopodium spp.							<1	13		
Chenopodium fremontii										
Chimiphila menzlesii										
Chimiphila umbellata	<1	14								
Cirsium spp.										

APPENDIX B: Table 2 (continued)

Type No:	16		17		19		18		20	
No. Plots:	(7)		(5)		(2)		(8)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Cirsium parryi										
Cirsium rothrockii										
Cirsium wheeleri										
Cirsium wrightii										
Cologania longifolia										
Comandra umbellata s. pallida							<1	13		
Conyza schiedeana							<1	13		
Corallorhiza spp.										
Corallorhiza striata									<1	20
Cosmos spp.	<1	13								
Cystopteris fragilis	<1	14	<1	20			<1	13		
Desmodium sp.										
Draba sp.							<1	13		
Draba helleriana										
Epilobium angustifolium										
Erigeron spp.	<1	14	1	20			<1	13		
Erigeron caespitosus										
Erigeron eximius			25	20	<1	50				
Erigeron formosissimus										
Erigeron neomexicanus	<1	14					<1	13		
Erigeron oreophilus										
Erigeron platyphyllus							<1	25	<1	20
Erigeron rusbyi	<1	29	1	20						
Erigeron speciosus					<1	50				
Erigeron subtrinervis	<1	29	<1	20						
Eriogonum spp.										
Eupatorium herbaceum	<1	14					<1	13		
Euphorbia spp.	<1	14								
Euphorbia brachycera										
Euphorbia chamaesula										
Fragaria americana	<1	43	8	20			<1	13		
Fragaria ovalis			<1	20	7	100	<1	13	5	40
Galium spp.										
Galium apparine					<1	50	1	13	3	20
Galium asperrinum					<1	50			<1	40
Galium boreale	<1	14								
Galium fendleri										
Galium microphyllum										
Galium rothroekii										
Galium tinctorium										
Galium triflorum	<1	14					<1	13		
Gentiana bigelovii										
Geranium spp.	<1	29	<1	20			3	13		
Geranium caespitosum	1	14					<1	13	<1	20
Geranium ereophilum										
Geranium richardsonii	<1	14	<1	80	4	100	<1	25	4	60
Gilia aggregata							<1	13		
Gilia multiflora										
Gilia spp.										
Gnaphalium spp										
Gnaphalium macounii									<1	20
Goodyera oblongifolia			<1	20	<1	38				
Haploppappus spp.										
Hedeoma spp.										
Hedeoma diffusum							<1	25		
Hedeoma hyssopifolium	<1	14								
Hedeoma oblongifolium										
Helenium hoopesii			<1	40						
Heracleum sphondylium			<1	20						

APPENDIX B: Table 2 (continued)

Type No:	16		17		19		18		20	
No. Plots:	(7)		(5)		(2)		(8)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Helianthella quinquenervis										
Heuchera spp										
Heuchera eastwoodiae							<1	13		
Heuchera parvifolia										
Heuchera versicolor										
Hieracium carneum										
Hieracium fendleri	<1	14					<1	13		
Hymenopappus mexicanus										
Iris misouriensis										
Lathyrus spp.			<1	20						
Lathyrus arizonicus			<1	40			<1	50	<1	20
Lathyrus graminifolius										
Lathyrus leucanthus										
Ligusticum porteri										
Linum neomexicanum										
Lithosperum multiflorum										
Lithosperum spp.										
Lotus wrightii							<1	13		
Lupinus spp.							1	13		
Lupinus hillii										
Malaxis soulei	1	57	<1	20			<1	13	<1	20
Monarda menthafolia										
Monotropa latisquama	<1	14			<1	50				
Oenothera spp.										
Oreochrysum parryi			3	20						
Osmorhiza chilensis									<1	20
Osmorhiza depauperata	<1	20								
Oxalis spp.	<1	29	<1	40			2	13		
Oxalis decaphylla										
Oxalis metcalfei			10	20			7	13	3	40
Oxybaphus spp.										
Oxybaphus comatus							1	13		
Pelleae spp.										
Penstemon spp.					<1	50				
Penstemom barbatus	<1	14								
Penstemon virgatus										
Perityle ciliata										
Phacelia spp										
Phaseolus spp.										
Phaseolus parvulus							<1	13		
Potentilla spp.			<1	20	<1	50				
Potentilla hippiana										
Potentilla thurberi							1	13		
Potentilla visidula										
Prunella vulgaris										
Pseudocymopterus montanus	<1	43	<1	40	<1	50	<1	75		
Pteridium aquilinum	<1	57	3	40			2	13	1	20
Pyrola chlorantha	<1	43	<1	60						
Pyrola picta										
Salvia arizonica										
Saxifraga					<1	100	<1	13	<1	20
Scrophularia parvifolia							<1	13		
Senecio bigelovii										
Senecio eremophilus	<1	14								
Senecio neomexicanus							<1	25		
Senecio spartiodes										
Senecio wootoni	<1	57	<1	40	<1	50			<1	20
Silene spp.	<1	14	<1	20						
Silene laciniata	<1	13								

APPENDIX B: Table 2 (continued)

	Type No:	16		17		19		18		20	
	No. Plots:	(7)		(5)		(2)		(8)		(5)	
		D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Silene scouleri		<1	14								
Sisymbrium linearifolium											
Smilacina racemosa		<1	14	<1	20	<1	50	<1	38	3	40
Smilacina stellata				<1	20	<1	50			<1	20
Solidago decumbens											
Solidago spp.								2	13		
Solidago sparsiflora								<1	38		
Solidago wrightii								<1	13		
Stevia spp.											
Stevia plummerae											
Stevia serrata											
Thalictrum fendleri		<1	57	13	40	<1	100	1	88	1	100
Thelypodium spp											
Thelypodium wrightii						<1	50				
Thermopsis pinetorum		<1	29			<1	50			<1	20
Thlaspi fendleri											
Tragia ramosa											
Valeriana spp.										3	20
Valeriana arizonica						10	50				
Verbena bipinnatifida											
Verbesina longifolia								<1	13		
Vicia spp.											
Vicia americana		<1	29	2	80			<1	13	1	40
Vicia pulchella								1	13		
Viguiera multiflora											
Viola canadensis		<1	14	15	40	3	100	<1	50	3	80
Woodsia mexicana											

	Type No:	21		24		22		23		25	
	No. Plots:	(1)		(2)		(12)		(1)		(19)	
		D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES											
Abies concolor (yng. regen.)		34	100	5	50	2	25			6	21
Abies concolor (adv. regen.)		10	100			1	25				
Abies concolor (mature)		12	100							1	5
Abies lasiocarpa (yng. regen.)											
Acer glabrum (yng. regen.)											
Acer glabrum (adv. regen.)											
Acer glabrum (mature)											
Acer grandidentatum (y.regen.)											
Acer grandidentatum (a.regen.)											
Acer grandidentatum (mature)											
Acer negundo (y regen)		1	100								
Acer negundo (mature)		1	100								
Arbutus arizonica (y. regen.)											
Arbutus arizonica (a. regen.)											
Fraxinus pennsylvanica (y.reg)								6	21		
Fraxinus pennsylvanica (a.reg)								3	5		
Juglans major (yng. regen.)		2	100							1	5
Juglans major (adv.regen.)											
Juglans major (mature)		2	100								
Juniperus deppeana (y. regen.)		1	100							62	26
Juniperus deppeana (a. regen.)										5	16
Juniperus deppeana (mature)										1	5
Juniperus scopulorum (y. rg.)											
Picea engelmannii (yng. regen)											
Picea engelmannii (adv. regen)											
Picea engelmannii (mature)											

APPENDIX B: Table 2 (continued)

Type No:	21		24		22		23		25	
No. Plots:	(1)		(2)		(12)		(1)		(19)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Picea pungens (y. regen)										
Picea pungens (a. regen)										
Picea pungens (mature)										
Pinus discolor (yng. regen.)									3	11
Pinus discolor (adv. regen.)									1	11
Pinus edulis (yng. regen.)										
Pinus engelmannii (adv. regen)									7	5
Pinus engelmannii (mature)									1	5
Pinus ponderosa (yng. regen.)	1	100			12	100			5	63
Pinus ponderosa (adv. regen.)					7	17			4	37
Pinus ponderosa (mature)					6	17			4	32
Pinus strobiformis (yng. reg.)			16	100	13	100			5	53
Pinus strobiformis (adv. reg.)			2	100	4	67			6	21
Pinus strobiformis (mature)					2	42	3	100	2	16
Populus tremuloides (y. reg.)							1	100	8	11
Populus tremuloides (a. reg.)										
Populus tremuloides (mature)			1	50						
Prunus serotina (yng. reg.)										
Prunus serotina (adv. reg.)										
Prunus serotina (mature)										
Pseudotsuga menziesii (y. reg)	4	100	76	100	46	100	9	100	27	95
Pseudotsuga menziesii (a. reg)	11	100	12	100	12	75	16	100	10	89
Pseudotsuga menziesii (mature)			10	100	2	67	8	100	4	100
Quercus arizonica (y. regen.)										
Quercus arizonica (a. regen.)										
Quercus arizonica (mature)										
Quercus chrysolepis (y. reg.)									10	11
Quercus chrysolepis (a. reg.)										
Quercus chrysolepis (mature)										
Quercus emoryi (y. regen.)										
Quercus emoryi (a. regen.)										
Quercus gambelii (y. regen.)	5	100			4	8			8	58
Quercus gambelii (a. regen.)					1	8			17	84
Quercus gambelii (mature)	1	100							3	42
Quercus hypoleucoides (y.reg.)										
Quercus hypoleucoides (a.reg.)									5	5
Quercus hypoleucoides (mature)										
Quercus rugosa (y. regen.)									3	16
Quercus rugosa (a. regen.)									2	16
SHRUBS										
Acer glabrum									<1	5
Acer grandidentatum					<1	8				
Acer negundo										
Agave spp.									<1	5
Agave parryi										
Amelanchier utahensis										
Amorpha fruticosa									2	11
Arbutus arizonica										
Arctostaphylos pringlei									1	5
Baccharis thesioides									<1	5
Brickellia californica									<1	5
Ceanothus fendleri					<1	17			<1	16
Cercocarpus montanus									<1	5
Clematis columbiana									<1	5
Fendlera rupicola									<1	5
Fraxinus spp.									10	5
Fraxinus pennsylvanica									4	21
Garrya wrightii									<1	11

APPENDIX B: Table 2 (continued)

Type No:	21		24		22		23		25	
No. Plots:	(1)		(2)		(12)		(1)		(19)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Holodiscus dumosus			<1	50	3	8			<1	21
Jamesia americana										
Juglans major									1	16
Juniperus communis										
Juniperus deppeana (shrubs)									4	16
Lonicera spp.					<1	8				
Lonicera albiflora									<1	5
Lonicera arizonica									<1	11
Lonicera involcrata										
Lonicera utahensis										
Berberis repens	<1	100							<1	5
Nolina microcarpa										
Pachystima myrsinites									<1	5
Philadelphus microphyllus					2	8			<1	5
Populus tremuloides	1	100	2	11						
Prunus spp.									<1	5
Prunus emarginata										
Prunus serotina ssp. virens					<1	17			1	11
Ptelea angustifolia			<1	50	2	26				
Quercus arizonica	<1	8			<1	5				
Quercus chrysolepis									2	26
Quercus emoryi									<1	5
Quercus gambelii	<1	100			<1	17			25	100
Quercus hypoleucoides									<1	32
Quercus rugosa			<1	50	<1	33			4	37
Rhamnus betulaefolia					<1	17			3	21
Rhamnus californica										
Rhus aromatica									2	5
Rhus choriophylla									<1	5
Rhus glabra										
Ribes pinetotorum										
Robinia neomexicana	<1	100			<1	25			5	42
Rosa arizonica									<1	5
Rosa woodsii	<1	100							<1	5
Rubus idaeus var. strigosus										
Rubus leucodermis									1	5
Rubus neomexicanus	<1	100							2	21
Rubus parviflorus										
Salix scouleriana										
Sambucus melancarpa										
Sorbus dumosa										
Symphoricarpos oreophilus			<1	100					7	42
Symphoricarpos palmeri									1	5
Toxicodendron rydbergii	<1	100			<1	8			2	11
Vaccinium myrtillus										
Vitis arizonica	<1	100								
Yucca baccata									<1	5
Yucca schottii									<1	16
GRAMINOIDS										
Agropyron arizonicum					2	42			2	16
Agropyron subsecundum										
Aristida spp.							<1	100		
Aristida orcuttiana										
Blepharoneuron tricholepis							2	100		
Bromus spp.									<1	5
Bromopsis richardsonii	2	100	<1	100	<1	58	3	100	1	53
Bromopsis porteri									7	42
Carex spp.	<1	100			<1	8			<1	26

APPENDIX B: Table 2 (continued)

Type No:	21		24		22		23		25	
No. Plots:	(1)		(2)		(12)		(1)		(19)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Carex brevipes					<1	17			<1	5
Carex geophila					1	25	<1	100	<1	32
Carex rossii					1	8				
Cyperus fendlerianus										
Carex foenea			<1	50						
Dactylis glomerata									<1	5
Festuca spp.							<1	100		
Festuca arizonica									2	5
Festuca sororia										
Koelerla pyramidata					<1	83	<1	100	3	42
Muhlenbergla longilligula					<1	8	2	26		
Muhlenbergia montana							10	100		
Muhlenbergla virescens					16	100			<1	42
Panicum bulbosum					2	17	3	16		
Piptochaetium fimbriatum										
Poa fendleriana			3	50					4	68
Poa pratensis										
Sitanion hystrix									<1	21
Stipa pringlei					1	17			14	11
Tresetum spicatum v. montanum										
FORBS										
Achillea millefolium					2	17			1	37
Actea arguta										
Agastache sp.							<1	5		
Allium spp.			<1	50						
Allium cernuum					<1	17			<1	11
Androsace septentrionalis										
Antennaria spp.					<1	33				
Antennaria arida					<1	8			<1	5
Antennaria neglecta					<1	8			1	21
Antennaria parvifolia			<1	50	<1	8			<1	5
Anthericum torreyi									<1	5
Aquilegia spp										
Aquilegia elegantula									<1	5
Aquilegia chrysantha										
Arabis spp.									<1	5
Arenaria spp.					<1	8				
Arenaria lanuginosa									<1	16
Artemisia carruthii									<1	11
Artemisia ludoviciana	<1	100			<1	8			<1	11
Astragulus spp.					<1	8				
Bahia dissecta									<1	5
Besseya plantaginea					<1	8				
Bidens spp.										
Bidens lemmonii										
Brickellia spp.									<1	5
Brickellia betonieaefolia										
Brickellia brachyphylla							<1	100	<1	5
Brickellia grandiflora			<1	50					<1	26
Cacalia decomposita							1	5		
Campanula rotundifolia										
Castilleja spp										
Castilleja austromontana							<1	11		
Castilleja confusa					<1	8				
Castilleja integra										
Cerastium nutans										
Chaptalia alsophila									<1	5
Cheilanthes fendleri									<1	16

APPENDIX B: Table 2 (continued)

Type No:	21		24		22		23		25	
No. Plots:	(1)		(2)		(12)		(1)		(19)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Chenopodium spp.										
Chenopodium fremontii									<1	5
Chimiphila menziesii										
Chimiphila umbellata										
Cirsium spp.				<1	25			<1	5	
Cirsium parryi										
Cirsium rothrockii					<1	8				
Cirsium wheeleri									<1	5
Cirsium wrightii										
Cologania longifolia									<1	5
Comandra umbellata s. pallida			<1	11						
Conyza schiedeana										
Corallorhiza spp.			<1	50						
Corallorhiza striata										
Cosmos spp.										
Cystopteris fragilis									3	11
Desmodium sp.									<1	5
Draba sp.										
Draba helleriana										
Epilobium angustifolium										
Erigeron spp.			<1	50	<1	17			<1	5
Erigeron caespitosus										
Erigeron eximius										
Erigeron formosissimus										
Erigeron neomexicanus					<1	8	<1	100	<1	16
Erigeron oreophilus					<1	8				
Erigeron platyphyllus	<1	100								
Erigeron rusbyi					<1	17	<1	16		
Erigeron speciosus					<1	33	1	11		
Erigeron subtrinervis										
Eriogonum spp.					<1	25				
Eupatorium herbaceum					<1	33	<1	47		
Euphorbia spp.					<1	25				
Euphorbia brachycera									<1	11
Euphorbia chamaesula									<1	5
Fragaria americana					4	8			3	11
Fragaria ovalis	2	100					10	5		
Gallium spp.			<1	50	<1	42	1	100	1	21
Galium apparine										
Galium asperrinum	<1	100			3	8			2	47
Gallum boreale										
Galium fendleri			<1	50	<1	8			<1	26
Galium microphyllum									<1	5
Gallum rothroekii									<1	5
Galium tinctorium										
Galium triflorum									2	5
Gentiana bigelovii									<1	5
Geranium spp.					1	17			2	11
Geranium caespitosum									<1	21
Geranium ereophilum										
Geranium richardsonii	5	100			<1	25			<1	26
Gilia aggregata					<1	8				
Gilia multiflora									<1	5
Gilia spp.										
Gnaphalium spp.					<1	8				
Gnaphallum macounii										
Goodyera oblongifolia										
Haploppappus spp.										
Hedeoma spp.					<1	25				

APPENDIX B: Table 2 (continued)

Type No:	21		24		22		23		25	
No. Plots:	(1)		(2)		(12)		(1)		(19)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Hedeoma diffusum										
Hedeoma hyssopifolium			<1	50	<1	25			1	21
Hedeoma oblongifolium										
Helenium hoopesii										
Heracleum sphondylium										
Helianthella quinquenervis										
Heuchera spp										
Heuchera eastwoodiae									<1	5
Heuchera parvifolia									<1	11
Heuchera versicolor									<1	11
Hieracium carneum									<1	5
Hieracium fendleri					<1	83			<1	21
Hymenopappus mexicanus					<1	8				
Iris misouriensis										
Lathyrus spp.									<1	16
Lathyrus arizonicus	<1	100			<1	8			1	47
Lathyrus graminifolius			<1	50	<1	25			<1	21
Lathyrus leucanthus										
Ligusticum porteri									6	11
Linum neomexicanum									<1	5
Lithosperum multiflorum					<1	25			<1	5
Lithosperum spp.										
Lotus wrightii					<1	8			<1	5
Lupinus spp.										
Lupinus hillii					<1	8				
Malaxis soulei			<1	50			<1	100	<1	11
Monarda menthafolia	<1	100								
Monotropa latisquama										
Oenothera spp.					<1	17				
Oreochrysum parryi										
Osmorhiza chilensis										
Osmorhiza depauperata	<1	100								
Oxalis spp.									2	11
Oxalis decaphylla									<1	5
Oxalis metcalfei			<1	50	<1	8	<1	100	2	26
Oxybaphus spp.										
Oxybaphus comatus										
Pelleae spp										
Penstemon spp										
Penstemom barbatus					1	8	<1	100	<1	21
Penstemon virgatus										
Perityle ciliata									<1	5
Phacelia spp.	<1	100								
Phaseolus spp.					<1	8			<1	11
Phaseolus parvulus					<1	25				
Potentilla spp.	<1	100					<1	100	<1	11
Potentilla hippiana										
Potentilla thurberi										
Potentilla visidula					<1	8				
Prunella vulgaris										
Pseudocymopterus montanus			<1	50	<1	92	<1	100	<1	37
Pteridium aquilinum			<1	50	2	67			<1	26
Pyrola chlorantha										
Pyrola picta										
Salvia arizonica									<1	5
Saxifraga										
Scrophularia parvifolia									<1	21
Senecio bigelovii										
Senecio eremophilus					<1	8				

APPENDIX B: Table 2 (continued)

Type No:	21		24		22		23		25	
No. Plots:	(1)		(2)		(12)		(1)		(19)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Senecia neamexicanus					<1	25			<1	32
Senecio spartiades										
Senecia woatani			<1	50	<1	50			1	5
Silene spp.			<1	50			<1	100		
Silene laciniata					<1	25			<1	5
Silene scouleri									<1	11
Sisymbrium linearifalium										
Smilacina racemasa									<1	11
Smilacina stellata	<1	100	<1	50					<1	11
Salidaga decumbens										
Salidago spp.					<1	50			<1	11
Salidaga sparsiflara					<1	8			<1	21
Salidaga wrightii					<1	25	<1	100	<1	11
Stevia spp.	<1	8								
Stevia plummerae	<1	8	<1	5						
Stevia serrata					<1	8				
Thalictrum fendleri	<1	100	<1	100	<1	17			1	74
Thelypadium spp.									<1	5
Thelypadium wrightii										
Thermapsis pinetarum					15	8			14	16
Thlaspi fendleri									<1	11
Tragia ramasa									<1	5
Valeriana spp										
Valeriana arizanica					3	8				
Verbena bipinnatifida										
Verbesina langifalia									1	5
Vicia spp.					<1	8			<1	5
Vicia americana	<1	100	<1	50	1	17			<1	26
Vicia pulchella					<1	8			<1	5
Viguiera multiflara									<1	11
Viola canadensis	3	100							2	11
Waadsia mexicana									<1	5

Type No:	26		27		28		29	
No. Plots:	(2)		(6)		(5)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES								
Abies cancalar (yng. regen.)							5	20
Abies concalar (adv. regen.)					2	40	1	20
Abies cancalar (mature)								
Abies lasiacarpa (yng. regen.)								
Acer glabrum (yng. regen.)								
Acer glabrum (adv. regen.)								
Acer glabrum (mature)								
Acer grandidentatum (y.regen.)	52	100						
Acer grandidentatum (a.regen.)	20	100						
Acer grandidentatum (mature)								
Acer negundo (y regen)								
Acer negunda (mature)								
Arbutus arizanica (y. regen.)	1	50						
Arbutus arizanica (a. regen.)	2	50						
Fraxinus pennsylvanica (y.reg)	17	50						
Fraxinus pennsylvanica (a.reg)	1	50						
Juglans majar (yng. regen.)			1	33				
Juglans majar (adv.regen.)								
Juglans majar (mature)								
Juniperus deppeana (y. regen.)	2	50	2	33	2	60	28	80
Juniperus deppeana (a. regen.)					1	40	4	40

APPENDIX B: Table 2 (continued)

Type No:	26		27		28		29	
No. Plots:	(2)		(6)		(5)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Juniperus deppeana (mature)					2	20	1	20
Juniperus scopulorum (y. rg.)								
Picea engelmannii (yng. regen)								
Picea engelmannii (adv. regen)								
Picea engelmannii (mature)								
Picea pungens (y. regen)								
Picea pungens (a. regen)								
Picea pungens (mature)								
Pinus discolor (yng. regen.)	8	100	2	17	3	40		
Pinus discolor (adv. regen.)	1	50			2	20		
Pinus edulis (yng. regen.)					12	40	3	60
Pinus engelmannii (adv. regen)								
Pinus engelmannii (mature)								
Pinus ponderosa (yng. regen.)			5	50	2	80	25	60
Pinus ponderosa (adv. regen.)	1	50	4	33	3	60	14	80
Pinus ponderosa (mature)			1	50	1	20	7	40
Pinus strobiformis (yng. reg.)			17	67	2	40		
Pinus strobiformis (adv. reg.)			5	83				
Pinus strobiformis (mature)			2	33				
Populus tremuloides (y. reg.)								
Populus tremuloides (a. reg.)								
Populus tremuloides (mature)								
Prunus serotina (yng. reg.)	3	50	2	33				
Prunus serotina (adv. reg.)			1	17				
Prunus serotina (mature)			1	17				
Pseudotsuga menziesii (y. reg)	5	100	30	100	6	80	17	100
Pseudotsuga menziesii (a. reg)	2	100	8	100	7	100	16	100
Pseudotsuga menziesii (mature)	4	100	6	100	2	100	3	100
Quercus arizonica (y. regen.)	5	60						
Quercus arizonica (a. regen.)	1	17	8	60	25	100		
Quercus arizonica (mature)	5	50	2	17	1	20	2	100
Quercus chrysolepis (y. reg.)	6	50	4	17				
Quercus chrysolepis (a. reg.)	8	50						
Quercus chrysolepis (mature)								
Quercus emoryi (y. regen.)							4	40
Quercus emoryi (a. regen.)							4	40
Quercus gambelii (y. regen.)	2	50			1	20		
Quercus gambelii (a. regen.)					10	20	3	20
Quercus gambelii (mature)								
Quercus hypoleucoides (y.reg.)	3	50	8	17	4	20		
Quercus hypoleucoides (a.reg.)	1	50	3	50	18	100		
Quercus hypoleucoides (mature)	2	40						
Quercus rugosa (y. regen.)	4	100	40	33	3	20		
Quercus rugosa (a. regen.)	2	100	19	67	2	40		
SHRUBS								
Acer glabrum								
Acer grandidentatum	65	100						
Acer negundo								
Agave spp.							<1	40
Agave parryi	<1	50						
Amelanchier utahensis								
Amorpha fruticosa								
Arbutus arizonica	4	50						
Arctostaphylos pringlei								
Baccharis thesioides					<1	20		
Brickellia californica					<1	20		
Ceanothus fendleri			<1	17	<1	40	<1	60
Cercocarpus montanus					<1	40		

APPENDIX B: Table 2 (continued)

Type No:	26		27		28		29	
No. Plots:	(2)		(6)		(5)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Clematis columbiana								
Fendlera rupicola								
Fraxinus spp.								
Fraxinus pennsylvanica	2	100						
Garrya wrightii	<1	100	<1	33	<1	60	<1	40
Holodiscus dumosus	2	50	<1	17				
Jamesia americana								
Juglans major			<1	33			<1	20
Juniperus communis								
Juniperus deppeana (shrubs)							<1	80
Lonicera spp.					<1	20		
Lonicera albiflora								
Lonicera arizonica	3	100						
Lonicera involcrata								
Lonicera utahensis								
Berberis repens	1	50						
Nolina microcarpa	<1	50			<1	20		
Pachystima myrsinites			1	17	<1	40		
Philadelphus microphyllus								
Populus tremuloides								
Prunus spp.								
Prunus emarginata								
Prunus serotina ssp. virens	2	50	2	33			<1	20
Ptelea angustifolia	3	50	<1	17				
Quercus arizonica	15	50	3	17	16	60	20	100
Quercus chrysolepis	5	100	15	17			<1	20
Quercus emoryi	3	60						
Quercus gambelii	2	50	5	80	<1	40		
Quercus hypoleucoides	1	50	3	83	26	100		
Quercus rugosa	5	100	28	100	4	80		
Rhamnus betulaefolia	3	50	<1	50				
Rhamnus californica							<1	20
Rhus aromatica	<1	50	1	33	2	20		
Rhus chorlophylla								
Rhus glabra								
Ribes pinetotorum								
Robinia neomexicana	2	50	<1	17	<1	40		
Rosa arizonica								
Rosa woodsii								
Rubus idaeus var. strigosus								
Rubus leucodermis								
Rubus neomexicanus	5	50						
Rubus parviflorus								
Salix scouleriana								
Sambucus melancarpa								
Sorbus dumosa								
Symphoricarpos oreophilus	3	50	<1	17	<1	20		
Symphoricarpos palmeri								
Toxicodendron rydbergii			<1	17				
Vaccinium myrtillus								
Vitis arizonica	<1	50	<1	17				
Yucca baccata								
Yucca schottii			<1	33	1	20		
GRAMINOIDS								
Agropyron arizonicum					<1	20		
Agropyron subsecundum	<1	50						
Aristida spp.					<1	20		
Aristida orcuttiana					<1	20		

APPENDIX B: Table 2 (continued)

Type No:	26		27		28		29	
No. Plots:	(2)		(6)		(5)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Blepharoneuron tricholepis					<1	20		
Bromus spp.								
Bromopsis richardsonii	<1	100	<1	50			<1	20
Bromopsis porteri					<1	40		
Carex spp.							<1	20
Carex brevipes					2	40		
Carex geophila			<1	50	<1	60	<1	60
Carex rossii							<1	20
Cyperus fendlerianus							<1	20
Carex foenea								
Dactylis glomerata								
Festuca spp.								
Festuca arizonica								
Festuca sororia								
Koeleria pyramidata			<1	67	<1	80	2	40
Muhlenbergia longiligula			<1	50	22	60	1	100
Muhlenbergia montana			<1	17				
Muhlenbergia virescens			<1	17	<1	40		
Panicum bulbosum	<1	50	<1	33	2	20		
Piptochaetium fimbriatum	<1	20						
Poa fendleriana	25	50	2	33	<1	40	<1	80
Poa pratensis								
Sitanion hystrix					<1	40	<1	60
Stipa pringlei					<1	20		
Tresetum spicatum v. montanum								
FORBS								
Achillea millefolium								
Actea arguta								
Agastache sp.								
Allium spp.			<1	17				
Allium cernuum								
Androsace septentrionalis								
Antennaria spp.								
Antennaria arida								
Antennaria neglecta			<1	17	<1	20		
Antennaria parvifolia			<1	33	<1	20		
Anthericum torreyi								
Aquilegia spp								
Aquilegia elegantula								
Aquilegia chrysantha								
Arabis spp.								
Arenaria spp.								
Arenaria lanuginosa			<1	17				
Artemisia carruthii								
Artemisia ludoviciana					<1	40		
Astragulus spp								
Bahia dissecta								
Besseya plantaginea								
Bidens spp.								
Bidens lemmonii					<1	20		
Brickellia spp.							<1	20
Brickellia betonieaefolia			<1	17				
Brickellia brachyphylla			<1	33				
Brickellia grandiflora	2	100	<1	33	1	40		
Cacalia decomposita								
Campanula rotundifolia								
Castilleja spp								
Castilleja austromontana								

APPENDIX B: Table 2 (continued)

Type No:	26		27		28		29	
No. Plots:	(2)		(6)		(5)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Castilleja confusa								
Castilleja integra			<1	17				
Cerastium nutans								
Chaptalia alsophila								
Cheilanthes fendleri					<1	40	<1	20
Chenopodium spp.					<1	40		
Chenopodium fremontii								
Chimiphila menziesii			<1	17				
Chimiphila umbellata								
Cirsium spp.					<1	20		
Cirsium parryi								
Cirsium rothrockii								
Cirsium wheeleri								
Cirsium wrightii								
Cologania longifolia					<1	20		
Comandra umbellata s. pallida					1	60	<1	80
Conyza schiedeana								
Corallorhiza spp.								
Corallorhiza striata								
Cosmos spp.					<1	20		
Cystopteris fragilis	<1	50			<1	20		
Desmodium sp.					<1	20		
Draba sp.								
Draba helleriana			<1	17				
Epilobium angustifolium								
Erigeron spp.			<1	17	<1	40	<1	20
Erigeron caespitosus								
Erigeron eximius								
Erigeron formosissimus								
Erigeron neomexicanus	<1	50			<1	40		
Erigeron oreophilus					<1	17		
Erigeron platyphyllus								
Erigeron rusbyi								
Erigeron speciosus								
Erigeron subtrinervis								
Eriogonum spp.					<1	20		
Eupatorium herbaceum	<1	50			<1	40		
Euphorbia spp.								
Euphorbia brachycera								
Euphorbia chamaesula								
Fragaria americana								
Fragaria ovalis								
Galium spp.								
Galium apparine			<1	17				
Galium asperrinum	2	100						
Galium boreale								
Galium fendleri			<1	17				
Galium microphyllum								
Galium rothroekii								
Galium tinctorium			<1	50				
Galium triflorum					<1	20		
Gentiana bigelovii								
Geranium spp.								
Geranium caespitosum	<1	50	<1	17			<1	20
Geranium ereophilum							<1	20
Geranium richardsonii								
Gilia aggregata								
Gilia multiflora								
Gilia spp.					<1	20		

APPENDIX B: Table 2 (continued)

Type No:	26		27		28		29	
No. Plots:	(2)		(6)		(5)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Gnaphalium spp								
Gnaphalium macounii								
Goodyera oblongifolia								
Haploppappus spp.							<1	20
Hedeoma spp.					<1	20		
Hedeoma diffusum								
Hedeoma hyssopifolium			<1	67	<1	20		
Hedeoma oblongifolium							<1	20
Helenium hoopesii								
Heracleum sphondylium								
Helianthella quinquenervis								
Heuchera spp.			<1	17				
Heuchera eastwoodiae								
Heuchera parvifolia	<1	50						
Heuchera versicolor			<1	17	<1	20		
Hieracium carneum								
Hieracium fendleri			<1	17			<1	20
Hymenopappus mexicanus								
Iris missouriensis								
Lathyrus spp.								
Lathyrus arizonicus								
Lathyrus graminifolius			<1	50				
Lathyrus leucanthus							<1	20
Ligusticum porteri								
Linum neomexicanum							<1	20
Lithosperum multiflorum							<1	20
Lithosperum spp.			<1	17				
Lotus wrightii					<1	20		
Lupinus spp.					1	20		
Lupinus hillii								
Malaxis soulei			<1	33	<1	20		
Monarda menthafolia								
Monotropa latisquama								
Oenothera spp.								
Oreochrysum parryi								
Osmorhiza chilensis								
Osmorhiza depauperata								
Oxalis spp.								
Oxalis decaphylla								
Oxalis metcalfei	<1	50	<1	17				
Oxybaphus spp.			<1	17				
Oxybaphus comatus					<1	40		
Pelleae spp.			<1	17	<1	20		
Penstemon spp								
Penstemom barbatus			<1	17	<1	40	<1	20
Penstemon virgatus					<1	20		
Perityle ciliata								
Phacelia spp								
Phaseolus spp.			<1	17	<1	20		
Phaseolus parvulus								
Potentilla spp.								
Potentilla hippiana								
Potentilla thurberi								
Potentilla visidula								
Prunella vulgaris								
Pseudocymopterus montanus	<1	33	<1	20	<1	60		
Pteridium aquilinum								
Pyrola chlorantha								
Pyrola picta								

APPENDIX B: Table 2 (continued)

Type No:	26		27		28		29	
No. Plots:	(2)		(6)		(5)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Salvia arizonica								
Saxifraga					<1	20		
Scrophularia parvifolia								
Senecio bigelovii								
Senecio eremophilus					<1	20		
Senecio neomexicanus			<1	50	<1	40	<1	40
Senecio spartioides								
Senecio wootoni								
Silene spp.					<1	20		
Silene laciniata					<1	20		
Silene scouleri								
Sisymbrium linearifolium					<1	20		
Smilacina racemosa								
Smilacina stellata								
Solidago decumbens								
Solidago spp.			<1	17	2	40		
Solidago sparsiflora	<1	50	<1	40				
Solidago wrightii			<1	17	1	20		
Stevia spp.								
Stevia plummerae								
Stevia serrata								
Thalictrum fendleri	<1	50	<1	67	<1	40	<1	40
Thelypodium spp								
Thelypodium wrightii								
Thermopsis pinetorum								
Thlaspi fendleri								
Tragia ramosa								
Valeriana spp.			<1	17				
Valeriana arizonica								
Verbena bipinnatifida					<1	20		
Verbesina longifolia					<1	20		
Vicia spp.								
Vicia americana	<1	50	<1	33				
Vicia pulchella								
Vigulera multiflora	<1	50						
Viola canadensis								
Woodsia mexicana								

Table 3. Species average density (D) or cover (C) and constancy (CON) for the Pinus ponderosa series.

Type No. 30=Pinus ponderosa/Festuca arizonica HT
Type No. 31=Pinus ponderoso/Muhlenbergia virescens HT
Type No. 32=Pinus ponderosa/Muhlenbergia montana HT
Type No. 33o=Pinus ponderoso/Quercus gombelii HT Quercus gombelii PH
Type No. 34o=Pinus ponderosa/Boutelouo grocilis HT Boutelouo gracilis PH
Type No. 33c=Pinus ponderoso/Quercus gombelii HT Pinus edulis PH
Type No. 33b=Pinus ponderoso/Quercus gombelii HT Muhlenbergia longiliga PH
Type No. 33d=Pinus ponderosa/Quercus gambelii HT Boutelouo gracilis PH
Type No. 34b=Pinus ponderoso/Boutelouo grocilis HT Artemisia tridentoto PH
Type No. 35=Pinus ponderosa/Juglans mojor HT
Type No. 36=Pinus ponderosa/Acer grandidentatum HT
Type No. 37=Pinus ponderoso/Quercus rugoso HT
Type No. 38=Pinus ponderoso/Quercus hypoleucoides HT
Type No. 39=Pinus ponderosa/Quercus orizonico HT
Type No. 39bPinus ponderoso/Quercus orizonico HT Boutelouo grocilis PH
Type No. 40=Pinus ponderoso/Quercus emoryi HT
Type No. 41=Pinus ponderoso/Arctostophylos pungens ct

Type No:	30		31		32		33a		34a	
No. Plots:	(1)		(12)		(3)		(9)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Abies concolor (yng. regen.)										
Abies concolor (adv. regen.)										
Acer grondidentatum (y.regen.)										
Acer grandidentotum (o.regen.)										
Acer negundo (moture)										
Alnus oblongifolio (moture)										
Arbutus orizonica (y. regen.)										
Arbutus arizonico (o. regen.)										
Arbutus orizonico (moture)										
Froxinus pennsylvonico (y.reg)										
Froxinus pennsylvanica (a.reg)										
Fraxinus pennsylvonico (motur)										
Juglons mojor (yng. regen.)									4	33
Juglans major (adv.regen.)										
Juglans major (mature)										
Juniperus deppeono (y. regen.)			2	50	10	100	26	22	8	67
Juniperus deppeono (a. regen.)			1	17			8	22	15	67
Juniperus deppeana (mature)			1	8	3	33	2	11	1	33
Juniperus osteosperma (y. rg.)									5	67
Juniperus osteospermo (od.rg.)									3	67
Juniperus scopulorum (y. rg.)									1	33
Juniperus scopulorum (adv.rg.)										
Picea engelmonnii (yng. regen)			1	8						
Pinus discolor (yng. regen.)			12	8	5	33				
Pinus discolor (odv. regen.)					2	33				
Pinus edulis (yng. regen.)			6	8	8	33	4	11	29	67
Pinus edulis (odv. regen.)					1	33	3	67		
Pinus engelmonnii (yng. regen)										
Pinus engelmannii (adv. regen)										
Pinus engelmonnii (moture)										
Pinus leiophyllo (yng. regen.)										
Pinus leiophylla (adv. regen.)										
Pinus leiophylla (mature)										
Pinus monophyllo (yng. reg.)										
Pinus monophylla (mature)										
Pinus ponderoso (yng. regen.)	37	100	28	92	11	67	14	67	28	100
Pinus ponderosa (adv. regen.)	1	100	12	50	27	33	19	56	12	100
Pinus ponderoso (moture)	9	100	8	42	4	33	8	56	3	100
Pinus strobiformis (yng. reg.)			6	58	3	33	17	22		
Pinus strobiformis (adv. reg.)			2	33			5	22		

Appendix B: Table 3 (continued)

Type No: / No. Plots:	30 (1)		31 (12)		32 (3)		33a (9)		34a (3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Pinus strobiformis (mature)					1	33				
Populus tremuloides (y. reg.)	7	100								
Pseudotsuga menziesii (y. reg)			8	33						
Pseudotsuga menziesii (a. reg)			5	25			1	22		
Pseudotsuga menziesii (mature)										
Quercus arizonica (y. regen.)										
Quercus arizonica (a. regen.)										
Quercus arizonica (mature)										
Quercus chrysolepis (y. reg.)										
Quercus chrysolepis (a. reg.)										
Quercus emoryi (y. regen.)										
Quercus emoryi (a. regen.)										
Quercus emoryi (mature)										
Quercus gambelii (y. regen.)			3	17	1	33	11	78	7	67
Quercus gambelii (a. regen.)			7	25	11	89	6	33		
Quercus gambelii (mature)			2	8			3	78		
Quercus hypoleucoides (y.reg.)			1	8						
Quercus hypoleucoides (a.reg.)			2	8						
Quercus hypoleucoides (mature)			1	8						
Quercus rugosa (y. regen.)			2	8			1	11		
Quercus rugosa (a. regen.)			1	8			2	11		
Quercus rugosa (mature)										
SHRUBS										
Acer grandidentatum										
Agave spp.										
Agave chrysantha			<1	8						
Agave palmeri										
Agave parryi										
Amelanchier oreophila			<1	8						
Amorpha fruticosa										
Apocynum androsaemifolium			<1	8						
Arbutus arizonica										
Arctostaphylos pringlei										
Arctostaphylos pungens									<1	33
Artemisia tridentata									<1	33
Baccharis thesioides										
Brickellia californica										
Carphochaete bigelovii										
Ceanothus fendleri			3	50			<1	22		
Ceanothus greggii										
Cercocarpus montanus										
Cowania mexicana									<1	33
Fallugia paradoxa										
Fraxinus pennsylvanica										
Garrya flavescens										
Garrya wrightii										
Gutirrezia lucida									<1	67
Holodiscus dumosus			3	33	1	11				
Hymenoxys richardsonii										
Hymenoxys rusbyi										
Lonicera spp.										
Lonicera albiflora										
Lonicera arizonica										
Berberis repens							<1	33		
Mimosa bunciifera										
Nolina microcarpa										
Opuntia spp.										
Opuntia plumbea									<1	100

Appendix B: Table 3 (continued)

Type No: / No. Plots:	30 (1)		31 (12)		32 (3)		33a (9)		34a (3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Opuntia spinosior										
Opuntia whiplei									<1	33
Prunus serotina ssp. virens										
Prunus virginiana							<1	11		
Ptelea angustifolia							<1	22		
Quercus arizonica							<1	22		
Quercus chrysolepis			<1	25	<1	33				
Quercus emoryi							<1	11		
Quercus gambelii			4	42	2	33	19	100	3	100
Quercus hypoleucoides			2	42						
Quercus rugosa			3	33			1	22		
Quercus turbinella									<1	33
Rhamnus betulaefolia			<1	8						
Rhamnus crocea										
Rhus aromatica									<1	67
Ribes cereum							<1	11		
Robinia neomexicana							3	56		
Rosa arizonica							1	11		
Rosa woodsii	2	100	<1	8						
Rubus neomexicanus										
Salix pseudocordata										
Symphoricarpos oreophilus					<1	33	1	44		
Symphoricarpos parishii										
Symphoricarpos rotundifolius							<1	11		
Toxicodendron rydbergii										
Vitis arizonica										
Yucca baccata							<1	11		
Yucca schottii										
GRAMINOIDS										
Agropyron spp.									4	33
Agropyron arizonicum										
Agropyron subsecundum										
Schizachyrium spp.										
Schizachyrium cirratum			<1	8	2	33				
Aristida spp.										
Aristida fendleriana									<1	67
Aristida orcuttiana									<1	33
Blepharoneuron tricholepis	<1	100	<1	25	<1	67	<1	11		
Bouteloua curtipendula									<1	33
Bouteloua gracilis					9	33			9	100
Bromus spp.										
Bromus tectorum										
Bromopsis richardsonii	<1	100	<1	42	<1	33	4	22		
Bromopsis porteri			5	17	1	33	8	22		
Carex spp.	5	100	4	25			1	44	1	33
Carex geophila			4	42	4	67	8	78	<1	33
Carex hoodii										
Carex rossii					1	33				
Cyperus spp.										
Cyperus fendlerianus									<1	67
Cyperus rusbyi							<1	11		
Dactylis glomerata										
Festuca arizonica	40	100	<1	11						
Koeleria pyramidata	<1	100	<1	42	3	100	2	44	<1	67
Lycurus phleoides										
Muhlenbergia spp										
Muhlenbergia emersleyi										
Muhlenbergia fragilis										

Appendix B: Table 3 (continued)

Type No:	30		31		32		33a		34a	
No. Plots:	(1)		(12)		(3)		(9)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Muhlenbergia glauca										
Muhlenbergia longiligula			2	42	<1	33	<1	11		
Muhlenbergia montana	4	100	<1	25	15	100	<1	11		
Muhlenbergia racemisa										
Muhlenbergia virescens	1	100	21	100			2	22		
Panicum bulbosum			<1	8						
Piptochaetium fimbriatum										
Poa spp.							1	11		
Poa fendleriana	<1	100	<1	42	<1	33	<1	56	<1	67
Poa pratensis	2	100	1	33						
Schizachyrium scoparium										
Setaria grisebachii										
Sitanion hystrix	<1	100	<1	25	<1	67	1	78	<1	67
Sporobolus spp.			<1	8						
Sporobolus interruptus										
Stipa columbiana										
Stipa comata							<1	11	<1	33
Stipa pringlei			<1	42	2	67	1	11		
Stipa spp.										
FORBS										
Achillea millefolium	<1	100	35	8			<1	22		
Agoseris spp										
Amaranthus spp.							<1	11		
Ambrosia psilostachya									<1	33
Antennaria spp.			<1	8						
Antennaria neglecta			<1	8			<1	11		
Antennaria parvifolia							<1	22	<1	33
Antennaria rosulata									<1	33
Anthericum torreyi										
Arabis spp.							<1	11		
Arenaria spp.										
Arenaria eastwoodiae										
Arenaria lanuginosa			<1	25	<1	33	<1	33		
Artemisia carruthii			<1	8	<1	33	<1	22		
Artemisia dracunculoides			<1	8	<1	33	<1	11		
Artemisia ludoviciana							3	11		
Asclepias spp										
Astragulus spp.			<1	8					3	67
Astragalus cobrensis		<1	8							
Astragalus hallii										
Astragulus humistratus					<1	11				
Astragalus recurvus										
Astragalus tephrodes										
Aster bigelovii										
Aster commutatus			<1	8						
Aster exilis									<1	33
Bahia dissecta			<1	8	<1	33				
Bidens herterosperma							<1	11		
Bidens lemmonii										
Brickellia spp.										
Brickellia betonieaefolia										
Brickellia brachyphylla										
Brickellia fendleri										
Brickellia grandiflora			<1	8						
Cacalia decomposita			<1	8						
Calliandra humilis					<1	11	<1	33		
Calliandra reticulata			<1	8						
Castilleja spp										

Appendix B: Table 3 (continued)

Type No:	30		31		32		33a		34a	
No. Plots:	(1)		(12)		(3)		(9)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Castilleja austromontana							<1	11		
Castilleja integra										
Castilleja linariafolia										
Cerastium spp										
Chamaesaracha coronopus										
Cheilanthes fendleri							<1	11		
Chenopodium incisum										
Cirsium spp.			<1	25						
Cirsium arizonicum			<1	8						
Cirsium wheeleri			<1	8						
Cirsium wrightii	<1	100	<1	17					<1	33
Cologania longifolia			1	25	<1	33	<1	22		
Cologania pulchella			<1	8						
Cologania spp.										
Comandra umbellata s. pallida					<1	33				
Commelina spp.							<1	11		
Commelina dianthifolia					1	33	<1	11	<1	33
Commelina erecta							<1	11		
Corallorhiza striata			<1	8						
Cystopteris fragilis										
Desmanthus cooleyi										
Desmodium sp.			<1	8						
Desmodium batocaulon										
Desmodium grahami										
Desmodium rosei			<1	8						
Draba helleriana										
Drymaria tenella			<1	8						
Echinocactus spp.										
Echinocereus spp.										
Epilobium paniculatum										
Erigeron spp.										
Erigeron caespitosus										
Erigeron divergens	<1	100	<1	17					<1	67
Erigeron flagellaris					<1	33	<1	11		
Erigeron formosissimus			<1	8						
Erigeron neomexicanus			<1	50	<1	33			<1	33
Erigeron nudiflorus									1	67
Erigeron oreophilus										
Erigeron rusbyi			<1	17						
Erigeron speciosus										
Eriogonum spp.										
Eriogonum alatum									<1	100
Eriogonum racemosum							<1	22	<1	33
Euphorbia spp.	<1	100	<1	8			<1	11	<1	33
Euphorbia brachycera			<1	8						
Euphorbia chamaesula			<1	8						
Euphorbia palmeri										
Fragaria americana			<1	8						
Galactia wrightii			<1	8						
Gallium spp.										
Gallium asperrimum			1	17			<1	11		
Gallium fendleri			<1	8			<1	22		
Gallium microphyllum										
Gallium rothrockii										
Gallium wrightii										
Gaura gracilis									<1	33
Geranium caespitosum			<1	25	<1	33	<1	33	<1	33
Geranium ereophilum							<1	33	<1	33
Geranium richardsonii			<1	8			<1	11		

Appendix B: Table 3 (continued)

Type No:	30		31		32		33a		34a	
No. Plots:	(1)		(12)		(3)		(9)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Gilia aggregata									<1	33
Gilla multiflora										
Gilla polyantha										
Gilia spp.										
Gnaphalium spp										
Gnaphalium arizonicum					<1	33				
Gnaphalium macounii			<1	17						
Gnaphalium pringlei			<1	8						
Gnaphalium wrightii			<1	8	<1	33				
Haploppappus spp.										
Hedeoma spp.			<1	8						
Hedeoma dentatum										
Hedeoma hyssopifolium			<1	58			<1	11		
Hedeoma oblongifolium										
Hedyotis pygmaea			<1	8						
Heliopsis parvifolia										
Heterotheca fulcrata			<1	8					2	33
Heuchera parvifolia										
Hieracium spp.										
Hieracium carneum										
Hieracium fendleri			<1	83	<1	33	<1	11		
Hymenopappus filifolius lugens									<1	67
Hymenothrix wrightii										
Ipomea spp.					<1	33				
Ipomoea coccinea							<1	11		
Kuhnia rosmarinifolia										
Lathyrus spp.			1	8						
Lathyrus arizonicus			<1	17						
Lathyrus graminifolius					<1	67	<1	44		
Lathyrus leucanthus									<1	33
Lepedium spp										
Lepedium desiflorum									<1	33
Lepidium medium								<1	33	
Lesquerella intermedia									<1	33
Leucelene ericoides										
Linum aristatum							<1	11	<1	33
Linum lewisia			<1	8						
Linum neomexicanum							<1	11	<1	33
Linum puberlum							<1	11		
Linum spp.										
Lithosperum inclsum										
Lithosperum multiflorum			<1	8						
Lotus wrightii			<1	17	<1	33	<1	11	<1	33
Lotus spp.										
Lupinus spp.										
Lupinus argenteus			<1	8	<1	11	<1	33		
Lupinus blumeri					2	33				
Lupinus hillii										
Lupinus kingsii										
Lupinus palmeri										
Machaeranthera gracilis										
Malaxis soulei					<1	33	<1	11		
Mamalaria spp.									<1	33
Mamalaria arizonica										
Melilotus officinalis									<1	33
Mirablis pumila										
Monarda spp										
Monarda menthafolia										
Monarda pectinata			<1	8						

Appendix B: Table 3 (continued)

Type No:	30		31		32		33a		34a	
No. Plots:	(1)		(12)		(3)		(9)		(3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Monotropa hypopitys										
Oenothera spp.										
Osmorhiza chilensis										
Oxalis decaphylla			<1	8						
Oxalis greyi					<1	11				
Oxalis metcalfei			<1	8	<1	33	1	11		
Oxybaphus spp.										
Oxybaphus comatus										
Pedicularis spp.										
Pelleae spp										
Pelleae atropurpurea										
Pellaea wrightiana										
Pennelia micrantha										
Penstemon spp.							<1	11		
Penstemom barbatus			<1	8			<1	11	<1	33
Penstemon linariodes										
Penstemon oligonathus										
Penstemom pseudospectabilis										
Penstemon virgatus							<1	22	<1	33
Perityle ciliata			<1	8						
Phacelia spp										
Phacelia heterophylla					<1	33				
Phaseolus spp.										
Phaseolus wrightii			<1	8						
Phlox amabilis										
Plantago patagonica									<1	67
Plummera floribunda					1	33				
Polemonium spp										
Polygala alba										
Polygala longa										
Polygonum sawatchense							<1	11	<1	67
Potentilla spp.					<1	33				
Potentilla hippiana	<1	100					<1	11		
Potentilla subviscosa					<1	33	<1	11		
Potentilla visidula			<1	8						
Pseudocymopterus montanus	<1	100	<1	67	<1	33	<1	22		
Psoralea tenuiflora										
Pteridium aquilinum	2	100	2	33			<1	11		
Pterospora andromedea										
Pyrola picta			<1	8						
Salvia arizonica										
Saxifraga eriophora							<1	11		
Scrophularia parvifolia										
Sedum griffthsii							<1	11		
Senecio eremophilus							<1	11		
Senecio multilobatus									<1	33
Senecio neomexicanus			<1	42	<1	33	<1	11	<1	33
Senecio spartiodes									<1	33
Senecio wootoni	<1	100	<1	25	1	33	<1	22		
Silene laciniata			<1	17						
Silene scouleri			<1	8	<1	11				
Sisymbrium linearifolium	<1	100	<1	8	<1	11	<1	33		
Smilacina stellata			<1	8						
Solidago spp.			<1	8						
Solidago missouriensis										
Solidago sparsiflora			1	25	5	33	2	67	<1	100
Solidago wrightii			<1	42			<1	11		
Sphaeralcea spp										
Sphaeralcea fendleri									<1	33

Appendix B: Table 3 (continued)

Type No: / No. Plots:	30 (1)		31 (12)		32 (3)		33a (9)		34a (3)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Stevia spp.										
Stevia plummerae			1	8						
Stevia serrata			1	8						
Stelaria jamesiana	.		<1	8			<1	11		
Taraxacum officinale							<1	11	<1	33
Thalictrum fendleri	1	100	<1	8	<1	67				
Thelypodium longifolium							<1	22		
Thermopsis pinetorum			2	8						
Townsendia exscapa									<1	33
Tragia ramosa										
Tragopogon pratensis									<1	33
Trifolium pinetorum	<1	100	<1	8	2	33	3	11		
Verbascum thapsus									<1	33
Verbena spp										
Verbena bipinnatifida			<1	8			<1	11		
Vicia spp.										
Vicia americana							<1	33		
Vicia pulchella	<1	100	<1	8						
Viguiera annua										
Viguiera multiflora			<1	8			<1	11		
Viola canadensis										
Woodsia mexicana							<1	11		

Type No: / No. Plots:	33c (6)		33b (4)		33d (12)		34b (1)		35 (4)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Abies concolor (yng. regen.)										
Abies concolor (adv. regen.)										
Acer grandidentatum (y.regen.)										
Acer grandidentatum (a.regen.)										
Acer negundo (mature)									2	25
Alnus oblongifolia (mature)									1	25
Arbutus arizonica (y. regen.)										
Arbutus arizonica (a. regen.)										
Arbutus arizonica (mature)										
Fraxinus pennsylvanica (y.reg)										
Fraxinus pennsylvanica (a.reg)										
Fraxinus pennsylvanica (matur)										
Juglans major (yng. regen.)									10	75
Juglans major (adv.regen.)									7	75
Juglans major (mature)									1	75
Juniperus deppeana (y. regen.)	15	33	16	75	23	42			7	100
Juniperus deppeana (a. regen.)	11	33	10	50	9	42			4	75
Juniperus deppeana (mature)					2	8				
Juniperus osteosperma (y. rg.)	10	67			3	8	5	100		
Juniperus osteosperma (ad.rg.)	3	67	2	8						
Juniperus scopulorum (y. rg.)									5	50
Juniperus scopulorum (adv.rg.)									2	50
Picea engelmannii (yng. regen)										
Pinus discolor (yng. regen.)										
Pinus discolor (adv. regen.)										
Pinus edulis (yng. regen.)	13	83			6	25	1	100	2	25
Pinus edulis (adv. regen.)	1	17							2	25
Pinus engelmannii (yng. regen)										
Pinus engelmannii (adv. regen)										
Pinus engelmannii (mature)										
Pinus lelophylla (yng. regen.)										

Appendix B: Table 3 (continued)

Type No:	33c		33b		33d		34b		35	
No. Plots:	(6)		(4)		(12)		(1)		(4)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Pinus leiophylla (adv. regen.)										
Pinus leiophylla (mature)										
Pinus monophylla (yng. reg.)	3	17								
Pinus monophylla (mature)										
Pinus ponderosa (yng. regen.)	42	83	23	75	38	100	50	100	4	75
Pinus ponderosa (adv. regen.)	14	83	11	100	5	92	4	100	13	100
Pinus ponderosa (mature)	5	83	8	100	6	100	6	100	9	100
Pinus strobiformis (yng. reg.)										
Pinus strobiformis (adv. reg.)										
Pinus strobiformis (mature)										
Populus tremuloides (y. reg.)										
Pseudotsuga menziesii (y. reg)										
Pseudotsuga menziesii (a. reg)									2	25
Pseudotsuga menziesii (mature)										
Quercus arizonica (y. regen.)					1	8				
Quercus arizonica (a. regen.)			2	25	1	8			1	25
Quercus arizonica (mature)			1	25						
Quercus chrysolepis (y. reg.)										
Quercus chrysolepis (a. reg.)										
Quercus emoryi (y. regen.)										
Quercus emoryi (a. regen.)										
Quercus emoryi (mature)										
Quercus gambelii (y. regen.)	14	67	22	50	1	25				
Quercus gambelii (a. regen.)	9	83	19	100	8	75	1	100		
Quercus gambelii (mature)	1	17	1	75	1	8		4	25	
Quercus hypoleucoides (y.reg.)										
Quercus hypoleucoides (a.reg.)										
Quercus hypoleucoides (mature)									3	25
Quercus rugosa (y. regen.)										
Quercus rugosa (a. regen.)										
Quercus rugosa (mature)										
SHRUBS										
Acer grandidentatum										
Agave spp.										
Agave chrysantha										
Agave palmeri										
Agave parryi										
Amelanchier oreophila										
Amorpha fruticosa										
Apocynum androsaemifolium										
Arbutus arizonica										
Arctostaphylos pringlei										
Arctostaphylos pungens	<1	17	<1	25						
Artemisia tridentata							3	100		
Baccharis thesioides										
Brickellia californica										
Carphochaete bigelovii										
Ceanothus fendleri			<1	100	<1	8				
Ceanothus greggii	2	67								
Cercocarpus montanus	<1	17								
Cowania mexicana	<1	50								
Fallugia paradoxa										
Fraxinus pennsylvanica										
Garrya flavescens									<1	25
Garrya wrightii	<1	17							<1	50
Gutirrezia lucida	<1	33			<1	50	<1	100		
Holodiscus dumosus										
Hymenoxys richardsonii					<1	17				

Appendix B: Table 3 (continued)

	Type No:	33c		33b		33d		34b		35	
	No. Plots:	(6)		(4)		(12)		(1)		(4)	
		D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Hymenoxys rusbyi		<1	17			<1	17				
Lonicera spp.											
Lonicera albiflora											
Lonicera arizonica											
Berberis repens											
Mimosa biuncifera											
Nolina microcarpa		<1	17								
Opuntia spp.											
Opuntia plumbea		<1	50			<1	33				
Opuntia spinosior											
Opuntia whipplei											
Prunus serotina ssp. virens											
Prunus virginiana											
Ptelea angustifolia											
Quercus arizonica				<1	100	<1	17			<1	25
Quercus chrysolepis											
Quercus emoryi				<1	25						
Quercus gambelii		9	100	25	100	11	100	5	100	15	50
Quercus hypoleucoides										3	25
Quercus rugosa											
Quercus turbinella		2	50								
Rhamnus betulaefolia				<1	25					5	50
Rhamnus crocea											
Rhus aromatica										2	50
Ribes cereum											
Robinia neomexicana		4	17			1	17				
Rosa arizonica										<1	25
Rosa woodsii											
Rubus neomexicanus											
Salix pseudocordata										3	25
Symphoricarpos oreophilus						<1	8				
Symphoricarpos parishii											
Symphoricarpos rotundifolius											
Toxicodendron rydbergii										<1	25
Vitis arizonica										1	75
Yucca baccata											
Yucca schottii											
GRAMINOIDS											
Agropyron spp											
Agropyron arizonicum											
Agropyron subsecundum											
Schizachyrium spp.				<1	25					5	25
Schizachyrium cirratum											
Aristida spp.											
Aristida fendleriana						<1	17				
Aristida orcuttiana											
Blepharoneuron tricholepis				<1	50	1	8				
Bouteloua curtipendula		<1	17	<1	25					<1	50
Bouteloua gracilis		2	50	<1	25	4	83	4	100	<1	50
Bromus spp.		20	25								
Bromus tectorum		<1	17					<1	100		
Bromopsis richardsonii		<1	17	<1	50	<1	8			2	75
Bromopsis porteri											
Carex spp.				<1	25	<1	25				
Carex geophila		1	83	<1	75	1	67				
Carex hoodii											
Carex rossii											
Cyperus spp.										<1	50

Appendix B: Table 3 (continued)

Type No:	33c		33b		33d		34b		35	
No. Plots:	(6)		(4)		(12)		(1)		(4)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Cyperus fendlerianus			<1	25	<1	8				
Cyperus rusbyl										
Dactylis glomerata										
Festuca arizonica			<1	25						
Koeleria pyramidata	<1	17	<1	50	<1	17				
Lycurus phleoides										
Muhlenbergia spp										
Muhlenbergia emersleyl										
Muhlenbergia fragilis										
Muhlenbergia glauca										
Muhlenbergia longligula	<1	17	8	100					<1	25
Muhlenbergia montana					1	33				
Muhlenbergia racemisa									<1	25
Muhlenbergia virescens			1	25	1	8				
Panicum bulbosum									3	75
Piptochaetium fimbriatum										
Poa spp										
Poa fendleriana	2	100	<1	100	2	92	7	100	<1	25
Poa pratensis			<1	25					15	25
Schizacharium scoparium										
Setaria grisebachii										
Sitanion hystrix	<1	67	<1	100	<1	100			<1	50
Sporobolus spp.	<1	17								
Sporobolus interruptus			<1	25	4	25				
Stipa columbiana										
Stipa comata										
Stipa pringlei			<1	25	2	8			<1	50
Stipa spp.										
FORBS										
Achillea millefolium	<1	17	<1	25	<1	33			<1	75
Agoseris spp										
Amaranthus spp.										
Ambrosia psilostachya			<1	50	<1	8			<1	50
Antennaria spp.										
Antennaria neglecta			<1	25						
Antennaria parvifolia	<1	50	<1	25	<1	58	<1	100		
Antennaria rosulata										
Anthericum torreyl					<1	8				
Arabis spp.										
Arenaria spp.										
Arenaria eastwoodiae	<1	17								
Arenaria lanuginosa					<1	8				
Artemisia carruthii	<1	67	<1	25	<1	75	1	100	<1	25
Artemisia dracunculoides										
Artemisia ludoviciana			<1	25	<1	8				
Asclepias spp.	<1	17			<1	25				
Astragulus spp.	<1	33			<1	58				
Astragalus cobrensis									<1	25
Astragalus hallii										
Astragulus humistratus					<1	8				
Astragalus recurvus	<1	17								
Astragalus tephrodes										
Aster bigelovil										
Aster commutatus			<1	50	<1	25				
Aster exilis			<1	25						
Bahia dissecta			<1	75	<1	8				
Bidens herterosperma										
Bidens lemmonil										

Appendix B: Table 3 (continued)

Type No:	33c		33b		33d		34b		35	
No. Plots:	(6)		(4)		(12)		(1)		(4)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Brickellio spp.										
Brickellio betonicaefolio										
Brickellio brachyphyllo										
Brickellio fendleri										
Brickellio grandiflora			<1	25					<1	25
Cacalia decomposita										
Calliandra humilis			<1	50	<1	8				
Calliandra reticulata									<1	25
Castilleja spp										
Castilleja austromontana										
Castilleja integra	<1	17								
Castilleja linariifolia										
Cerastium spp.			<1	25						
Chamaesaracha coronopus					<1	8				
Chellanthes fendleri										
Chenopodium incisum										
Cirsium spp.					<1	8				
Cirsium arizonicum										
Cirsium wheeleri	<1	17			<1	42				
Cirsium wrightii			<1	25	<1	8				
Cologania longifolia			<1	50	<1	8			1	25
Cologania pulchella										
Cologania spp.							30	25		
Comandra umbellata s. pallida	<1	17	<1	25						
Commelina spp.										
Commelina dianthifolia										
Commelina erecta										
Corallorhiza striata										
Cystopteris fragilis										
Desmanthus cooleyi	<1	17								
Desmodium sp.										
Desmodium batocaulon										
Desmodium grahami										
Desmodium rosei										
Draba helleriana										
Drymaria tenella										
Echinocactus spp.										
Echinocereus spp.										
Epilobium paniculatum			<1	25						
Erigeron spp.			<1	25	<1	8				
Erigeron caespitosus	<1	17								
Erigeron divergens	<1	33	<1	50	<1	75	<1	100		
Erigeron flagellaris										
Erigeron formosissimus					<1	8				
Erigeron neomexicanus			<1	50						
Erigeron nudiflorus	<1	83	<1	25	<1	33			5	50
Erigeron oreophilus										
Erigeron rusbyi										
Erigeron speciosus									<1	25
Eriogonum spp.			<1	25						
Eriogonum alatum	<1	17	<1	25	<1	8				
Eriogonum racemosum	<1	100	<1	25	<1	83	<1	100		
Euphorbia spp.	<1	33			<1	8				
Euphorbia brachycera										
Euphorbia chamaesula										
Euphorbia palmeri										
Frasera americana										
Galactia wrightii										
Galium spp.										

Appendix B: Table 3 (continued)

Type No:	33c		33b		33d		34b		35	
No. Plots:	(6)		(4)		(12)		(1)		(4)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Galium asperrinum									6	50
Galium fendleri										
Galium microphyllum										
Galium rothroekii	<1	17								
Galium wrightii										
Gaura gracilis									<1	25
Geranium caespitosum			<1	25	10	50				
Geranium ereophilum	<1	17			<1	8			<1	50
Geranium richardsonii		<1	25							
Gilia aggregata			<1	25	<1	8			<1	25
Gilia multiflora										
Gilia polyantha	<1	17			<1	8				
Gilia spp.					<1	8				
Gnaphalium spp.					<1	8				
Gnaphalium arizonicum										
Gnaphalium macounii			<1	25						
Gnaphalium pringlei										
Gnaphalium wrightii										
Haploppappus spp.										
Hedeoma spp.			<1	25					<1	25
Hedeoma dentatum										
Hedeoma hyssopifolium									<1	25
Hedeoma oblongifolium			<1	50						
Hedyotis pygmaea										
Heliopsis parvifolia										
Heterotheca fulcrata					<1	25				
Heuchera parvifolia										
Hieracium spp.										
Hieracium carneum										
Hieracium fendleri	<1	33	<1	50	<1	33			<1	25
Hymenopappus filifolius lugens	<1	33			<1	17			<1	25
Hymenothrix wrightii									<1	25
Ipomea spp.									<1	25
Ipomoea coccinea										
Kuhnia rosmarinifolia										
Lathyrus spp.										
Lathyrus arizonicus									<1	25
Lathyrus graminifollus			<1	25					<1	25
Lathyrus leucanthus					<1	8				
Lepedium spp										
Lepedium desiflorum	<1	33			<1	25	<1	100		
Lepidium medium										
Lesquerella intermedia										
Leucelene ericoides										
Linum aristatum	<1	33			<1	17				
Linum lewisia	<1	17								
Linum neomexicanum			<1	50						
Linum puberlum										
Linum spp.										
Lithosperum incisum									1	25
Lithosperum multiflorum	<1	17	<1	25						
Lotus wrightii	<1	83	<1	75	<1	83	<1	100		
Lotus spp.										
Lupinus spp.										
Lupinus argenteus	<1	50								
Lupinus blumeri										
Lupinus hillii										
Lupinus kingsii	<1	17								
Lupinus palmeri	1	17								

Appendix B: Table 3 (continued)

Type No:	33c		33b		33d		34b		35	
No. Plots:	(6)		(4)		(12)		(1)		(4)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Machaeranthera gracilis									<1	25
Malaxis soulei										
Mamalaria spp										
Mamalaria arizonica					<1	8				
Melilotus officinalis										
Mirabilis pumila										
Monarda spp.									<1	25
Monarda menthafolia									<1	25
Monarda pectinata									2	25
Monotropa hypopitys										
Oenothera spp.					<1	8			<1	25
Osmorhiza chilensis									5	25
Oxalis decaphylla										
Oxalis greyi										
Oxalis metcalfei			<1	25					<1	25
Oxybaphus spp.			<1	25						
Oxybaphus comatus										
Pedicularis spp.										
Pelleae spp										
Pelleae atropurpurea										
Pellaea wrightiana										
Pennella micrantha										
Penstemon spp.							<1	100		
Penstemom barbatus	<1	33	<1	25	<1	8				
Penstemon linariodes	<1	67	<1	25	<1	8	<1	100		
Penstemon oligonathus			<1	25						
Penstemom pseudospectabilis										
Penstemon virgatus	<1	50			<1	33				
Perityle ciliata										
Phacelia spp										
Phacelia heterophylla										
Phaseolus spp.			1	25						
Phaseolus wrightii										
Phlox amabilis	<1	17								
Plantago patagonica	<1	17			<1	25	<1	100		
Plummera floribunda										
Polemonium spp										
Polygala alba										
Polygala longa										
Polygonum sawatchense	<1	17	<1	50	<1	50				
Potentilla spp.									3	50
Potentilla hippiana										
Potentilla subviscosa										
Potentilla visidula										
Pseudocymopterus montanus			<1	25						
Psoralea tenuiflora	<1	33								
Pteridium aquilinum									32	50
Pterospora andromedea										
Pyrola picta										
Salvia arizonica										
Saxifraga eriophora										
Scrophularia parvifolia									<1	25
Sedum griffithsii										
Senecio eremophilus										
Senecio multilobatus					<1	25				
Senecio neomexicanus			<1	25	<1	8			<1	25
Senecio spartiodes										
Senecio wootoni										
Silene laciniata										

Appendix B: Table 3 (continued)

Type No:	33c		33b		33d		34b		35	
No. Plots:	(6)		(4)		(12)		(1)		(4)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Silene scouleri										
Sisymbrium linearifolium	<1	50	<1	25	<1	25				
Smilacina stellata										
Solidago spp.										
Solidago missouriensis									<1	25
Solidago sparsiflora	<1	100			1	67			<1	50
Solidago wrightii										
Sphaeralcea spp.			<1	25						
Sphaeralcea fendleri					<1	25	<1	100		
Stevia spp.										
Stevia plummerae										
Stevia serrata										
Stelaria jamesiana										
Taraxacum officinale									<1	25
Thalictrum fendleri	<1	50	<1	25					<1	75
Thelypodium longifolium										
Thermopsis pinetorum										
Townsendia exscapa										
Tragia ramosa			<1	75	<1	8				
Tragopogon pratensis										
Trifolium pinetorum										
Verbascum thapsus	<1	17			<1	8				
Verbena spp										
Verbena bipinnatifida										
Vicia spp.										
Vicia americana			<1	25	<1	8				
Vicia pulchella										
Viguiera annua	<1	17								
Viguiera multiflora			<1	25	<1	58			<1	25
Viola canadensis									<1	25
Woodsia mexicana										

Type No:	36		37		38		39		39b	
No. Plots:	(2)		(10)		(22)		(29)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Abies concolor (yng. regen.)					5	5	4	3		
Abies concolor (adv. regen.)					1	5				
Acer grandidentatum (y.regen.)	18	100	1	3						
Acer grandidentatum (a.regen.)	9	100								
Acer negundo (mature)										
Alnus oblongifolia (mature)										
Arbutus arizonica (y. regen.)					1	5				
Arbutus arizonica (a. regen.)			1	10	3	23				
Arbutus arizonica (mature)	1	9								
Fraxinus pennsylvanica (y.reg)	2	100			1	5				
Fraxinus pennsylvanica (a.reg)	3	100			1	5				
Fraxinus pennsylvanica (matur)										
Juglans major (yng. regen.)					2	5	10	3		
Juglans major (adv.regen.)	1	50								
Juglans major (mature)										
Juniperus deppeana (y. regen.)	2	50			4	64	16	79	11	100
Juniperus deppeana (a. regen.)			1	10	2	14	8	66	5	100
Juniperus deppeana (mature)			1	10	1	9	1	14	3	40
Juniperus osteosperma (y. rg.)										
Juniperus osteosperma (ad.rg.)										
Juniperus scopulorum (y. rg.)							1	3		
Juniperus scopulorum (adv.rg.)							1	3		

Appendix B: Table 3 (continued)

Type No:	36		37		38		39		39b	
No. Plots:	(2)		(10)		(22)		(29)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Picea engelmannii (yng. regen)										
Pinus discolor (yng. regen.)	27	100	9	30	14	23	3	7		
Pinus discolor (adv. regen.)	7	100	6	20	5	5	1	7		
Pinus edulis (yng. regen.)					1	5	4	34	9	40
Pinus edulis (adv. regen.)							2	7	1	40
Pinus engelmannii (yng. regen)					3	9				
Pinus engelmannii (adv. regen)										
Pinus engelmannii (mature)					2	14				
Pinus leiophylla (yng. regen.)					3	9				
Pinus leiophylla (adv. regen.)			1	10	3	14				
Pinus leiophylla (mature)					4	5				
Pinus monophylla (yng. reg.)										
Pinus monophylla (mature)										
Pinus ponderosa (yng. regen.)	2	100	9	80	15	91	18	90	9	100
Pinus ponderosa (adv. regen.)		17	40	10	32	15	76	5	80	
Pinus ponderosa (mature)			6	30	6	36	9	72	5	80
Pinus strobiformis (yng. reg.)			5	60	5	27				
Pinus strobiformis (adv. reg.)			4	30	2	23				
Pinus strobiformis (mature)			2	10	2	9				
Populus tremuloides (y. reg.)										
Pseudotsuga menziesii (y. reg)			2	80	4	14	4	14		
Pseudotsuga menziesii (a. reg)			1	60	2	14	3	17		
Pseudotsuga menziesii (mature)			1	30	1	7				
Quercus arizonica (y. regen.)			2	20	10	32	5	66	4	80
Quercus arizonica (a. regen.)			1	10	7	64	12	100	5	100
Quercus arizonica (mature)					4	5	2	55	3	80
Quercus chrysolepis (y. reg.)										
Quercus chrysolepis (a. reg.)										
Quercus emoryi (y. regen.)							2	31	1	20
Quercus emoryi (a. regen.)							2	10	1	20
Quercus emoryi (mature)							1	3	1	20
Quercus gambelii (y. regen.)	3	50	36	10			3	24		
Quercus gambelii (a. regen.)	10	100	1	10			2	3		
Quercus gambelii (mature)	4	100					1	3		
Quercus hypoleucoides (y.reg.)	6	100	14	60	30	100	1	10		
Quercus hypoleucoides (a.reg.)			13	50	20	91	4	3		
Quercus hypoleucoides (mature)			1	10	1	14				
Quercus rugosa (y. regen.)			28	100	2	14				
Quercus rugosa (a. regen.)	1	100	8	70	2	5				
Quercus rugosa (mature)										
SHRUBS										
Acer grandidentatum	8	100								
Agave spp.										
Agave chrysantha										
Agave palmeri			<1	10						
Agave parryi	<1	50	<1	20	<1	14	1	3		
Amelanchier oreophila										
Amorpha fruticosa	2	50								
Apocynum androsaemifolium										
Arbutus arizonica			1	10	2	32	3	20		
Arctostaphylos pringlei			2	10	<1	5	1	14		
Arctostaphylos pungens			1	20	2	17				
Artemisia tridentata										
Baccharis thesioides	<1	50			<1	5				
Brickellia californica			<1	10			<1	3		
Carphochaete bigelovii					<1	9				
Ceanothus fendleri			<1	50	<1	36	<1	52	<1	20
Ceanothus greggii										

Appendix B: Table 3 (continued)

Type No: / No. Plots:	36 (2)		37 (10)		38 (22)		39 (29)		39b (5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Cercocorpus montonus	1	50	1	10	<1	14	<1	14		
Cowonio mexicono							<1	3		
Follugio porodoxo										
Fraxinus pennsylvonico	4	100	<1	10	<1	9				
Gorryo flovescens							<1	3		
Garryo wrightii	<1	50	<1	20	1	27	<1	31	<1	20
Gutirrezio lucido							2	7		
Holodiscus dumosus	<1	50	<1	10			<1	3		
Hymenoxys richordsonii										
Hymenoxys rusbyi										
Lonicera spp.							<1	3		
Lonicero olbifloro									<1	20
Lonicero orizonico										
Berberis repens							<1	3		
Mimosa biuncifera										
Nolina microcarpa	<1	50	2	20	2	36	<1	10		
Opuntio spp.							<1	7		
Opuntio plumbeo							<1	14		
Opuntio spinosior					<1	5	<1	3		
Opuntia whiplei										
Prunus serotino ssp. virens			<1	10			<1	14		
Prunus virginiono										
Pteleo angustifolio	<1	100					<1	14		
Quercus arizonico			1	20	7	64	21	100	20	100
Quercus chrysolepis					2	5	<1	7		
Quercus emoryi	<1	5	1	55	<1	40				
Quercus gombelii	40	100	5	30	<1	14	<1	69		
Quercus hypoleucoides	4	100	16	60	23	100	<1	14		
Quercus rugosa	1	100	19	100	<1	55				
Quercus turbinello	<1	14								
Rhamnus betulaefolio	<1	100			<1	27	<1	3	<1	20
Rhamnus crocea					<1	5	<1	17		
Rhus oromotico	1	100	1	10	1	5	<1	3		
Ribes cereum										
Robinio neomexicana	8	50	11	20			<1	7		
Rosa arizonica										
Rosa woodsii										
Rubus neomexiconus	<1	50								
Solix pseudocordoto										
Symphoricorpos oreophilus	20	100	<1	10	<1	5	<1	7		
Symphoricarpos parishii							<1	3		
Symphoricarpos rotundifolius							1	3		
Toxicodendron rydbergii	<1	50		<1	5					
Vitis orizonico					<1	5	1	3	5	20
Yucco boccota										
Yucca schottii					<1	14				
GRAMINOIDS										
Agropyron spp										
Agropyron orizonicum			1	10	13	14				
Agropyron subsecundum							<1	3		
Schizachyrium spp.							<1	3		
Schizachyrium cirratum							<1	7		
Aristido spp.									<1	20
Aristida fendleriono										
Aristido orcuttiono			<1	10	<1	9	<1	24	<1	20
Blephoroneuron tricholepis			<1	10			<1	3		
Boutelouo curtipendula	<1	50					<1	21	2	60
Boutelouo gracilis							<1	14	22	100

Appendix B: Table 3 (continued)

Type No: / No. Plots:	36 (2)		37 (10)		38 (22)		39 (29)		39b (5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Bromus spp.									<1	40
Bromus tectorum										
Bromopsis richardsonii	3	50	<1	10	<1	23	<1	17		
Bromopsis porteri	3	50	<1	20	<1	9				
Carex spp.			<1	20	<1	32	1	17	2	20
Carex geophila			1	70	<1	36	1	66		
Carex hoodii							<1	3		
Carex rossii							<1	3		
Cyperus spp.									<1	20
Cyperus fendlerianus							<1	3	<1	80
Cyperus rusbyi			<1	10						
Dactylis glomerata							<1	3		
Festuca arizonica	3	10								
Koeleria pyramidata	3	100	<1	30	2	41	1	62	<1	20
Lycurus phleoides										
Muhlenbergia spp.							<1	3		
Muhlenbergia emersleyi			<1	10	<1	5	2	7		
Muhlenbergia fragilis									<1	20
Muhlenbergia glauca			<1	10						
Muhlenbergia longiligula	8	100	1	30	4	77	2	79	<1	20
Muhlenbergia montana			4	10			2	3		
Muhlenbergia racemisa										
Muhlenbergia virescens			1	60	<1	55				
Panicum bulbosum	2	50	<1	10	4	9	<1	17		
Piptochaetium fimbriatum			<1	10			<1	7	<1	20
Poa spp										
Poa fendleriana	8	100	1	20	4	27	<1	62		
Poa pratensis										
Schizacharium scoparium							<1	3		
Setaria grisebachii										
Sitanion hystrix	<1	100			<1	5	<1	69	5	60
Sporobolus spp										
Sporobolus interruptus							<1	3		
Stipa columbiana							<1	3		
Stipa comata										
Stipa pringlei					3	9	2	14		
Stipa spp.									<1	20
FORBS										
Achillea millefolium							<1	14	<1	40
Agoseris spp.							<1	3		
Amaranthus spp.										
Ambrosia psilostachya							<1	10	2	80
Antennaria spp.										
Antennaria neglecta					<1	14	<1	7		
Antennaria parvifolia					<1	5	<1	7		
Antennaria rosulata										
Antherlcum torreyi							<1	3		
Arabis spp.									<1	20
Arenaria spp.							<1	3		
Arenaria eastwoodiae										
Arenaria lanuginosa			<1	20			<1	10		
Artemisia carruthii					<1	5	<1	24		
Artemisia dracunculoides			<1	20						
Artemisia ludoviciana	1	50	<1	20	<1	9	<1	21	4	40
Asclepias spp										
Astragulus spp.					<1	5	<1	10	<1	20
Astragalus cobrensis					<1	5				
Astragalus halii										

Appendix B: Table 3 (continued)

Type No: / No. Plots:	36 (2)		37 (10)		38 (22)		39 (29)		39b (5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Astragulus humistratus							<1	7		
Astragalus recurvus										
Astragalus tephrodes							<1	7		
Aster bigelovii										
Aster commutatus							<1	7	<1	40
Aster exilis										
Bahia dissecta			<1	20	<1	5	<1	10		
Bidens herterosperma			<1	10						
Bidens lemmonii					<1	5				
Brickellia spp.			<1	10						
Brickellia betonieaefolia							<1	10		
Brickellia brachyphylla					<1	5				
Brickellia fendleri					<1	5				
Brickellia grandiflora	<1	100					<1	3		
Cacalia decomposita					<1	5				
Calliandra humilis							<1	17	<1	100
Calliandra reticulata			<1	10			<1	7		
Castilleja spp										
Castilleja austromontana					<1	5				
Castilleja integra							<1	3	<1	20
Castilleja linariafolia										
Cerastium spp										
Chamaesaracha coronopus										
Cheilanthes fendleri	<1	50			<1	27				
Chenopodium incisum			<1	10						
Cirsium spp.					<1	5	<1	7	<1	20
Cirsium arizonicum							<1	3		
Cirsium wheeleri					<1	5			<1	20
Cirsium wrightii			<1	10						
Cologania longifolia					<1	5	<1	14	<1	40
Cologania pulchella			<1	10	<1	9				
Cologania spp.										
Comandra umbellata s. pallida			<1	20	<1	27	6	24		
Commelina spp.										
Commelina dianthifolia							<1	3		
Commelina erecta										
Corallorhiza striata										
Cystopteris fragilis					<1	5				
Desmanthus cooleyi										
Desmodium sp.							<1	3		
Desmodium batocaulon										
Desmodium grahami							<1	7	<1	20
Desmodium rosei									3	20
Draba helleriana					<1	5				
Drymaria tenella										
Echinocactus spp.							<1	3		
Echinocereus spp.			<1	20	<1	5				
Epilobium paniculatum										
Erigeron spp.										
Erigeron caespitosus										
Erigeron divergens							<1	24	<1	40
Erigeron flagellaris										
Erigeron formosissimus										
Erigeron neomexicanus			<1	20	<1	5	<1	17		
Erigeron nudiflorus							<1	7	<1	20
Erigeron oreophilus					<1	5				
Erigeron rusbyi										
Erigeron speciosus			<1	10			<1	3		
Eriogonum spp.							<1	3	<1	20

Appendix B: Table 3 (continued)

Type No:	36		37		38		39		39b	
No. Plots:	(2)		(10)		(22)		(29)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Eriogonum alatum							<1	3		
Eriogonum racemosum										
Euphorbia spp.					<1	9	<1	3	<1	20
Euphorbia brachycera					<1	5				
Euphorbia chamaesula			<1	20	<1	5				
Euphorbia palmeri							<1	3		
Fragaria americana										
Galactia wrightii					<1	5				
Galium spp.					<1	5	<1	3		
Galium asperrinum	1	100			<1	18	<1	3		
Galium fendleri			<1	30	<1	14				
Galium microphyllum							<1	14		
Galium rothroekii							<1	7		
Galium wrightii							<1	3		
Gaura gracilis									<1	40
Geranium caespitosum	<1	100	<1	40	<1	9	<1	14	<1	60
Geranium ereophilum							<1	3		
Geranium richardsonii										
Gilia aggregata			<1	10						
Gilia multiflora							<1	3	<1	20
Gilia polyantha										
Gilia spp.							<1	20		
Gnaphalium spp.							<1	3		
Gnaphalium arizonicum			<1	10			<1	3	<1	20
Gnaphalium macounii			<1	20			<1	3		
Gnaphalium pringlei										
Gnaphalium wrightii					<1	14				
Haploppappus spp.							<1	3		
Hedeoma spp.										
Hedeoma dentatum							<1	7		
Hedeoma hyssopifolium			<1	40	<1	36	<1	10		
Hedeoma oblongifolium					<1	5	<1	3		
Hedyotis pygmaea			<1	10						
Heliopsis parvifolia					<1	5				
Heterotheca fulcrata			<1	10						
Heuchera parvifolia					<1	5				
Hieracium spp.					<1	5				
Hieracium carneum							<1	7		
Hieracium fendleri			<1	20	<1	18	<1	10	<1	20
Hymenopappus filifolius lugens					<1	10	<1	20		
Hymenothrix wrightii										
Ipomea spp.							<1	3		
Ipomoea coccinea										
Kuhnia rosmarinifolia							<1	3		
Lathyrus spp.					<1	5				
Lathyrus arizonicus	<1	50			<1	5	<1	3		
Lathyrus graminifolius			<1	10	<1	9	<1	3		
Lathyrus leucanthus							<1	3	<1	20
Lepedium spp.									<1	20
Lepedium desiflorum										
Lepidium medium										
Lesquerella intermedia										
Leucelene ericoides										
Linum aristatum										
Linum lewisia										
Linum neomexicanum					<1	9	<1	10		
Linum puberlum										
Linum spp.									<1	20
Lithosperum incisum										

Appendix B: Table 3 (continued)

Type No:	36		37		38		39		39b	
No. Plots:	(2)		(10)		(22)		(29)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Lithosperum multiflorum					<1	5				
Lotus wrightii			<1	20	<1	9	<1	24	<1	20
Lotus spp.							<1	3	<1	20
Lupinus spp.					<1	5			<1	20
Lupinus argenteus										
Lupinus blumeri					<1	5	1	3		
Lupinus hilli										
Lupinus kingsii										
Lupinus palmeri							<1	3		
Machaeranthera gracilis									<1	60
Malaxis soulei					<1	9				
Mamalaria spp.							<1	3	<1	20
Mamalaria arizonica										
Melilotus officinalis										
Mirablis pumila										
Monarda spp.									<1	20
Monarda menthafolia	<1	100								
Monarda pectinata										
Monotropa hypopitys							<1	3		
Oenothera spp.			<1	5			<1	20		
Osmorhiza chilensis										
Oxalis decaphylla										
Oxalis greyi										
Oxalis metcalfei	<1	50								
Oxybaphus spp.					<1	9				
Oxybaphus comatus			<1	20						
Pedicularis spp.							<1	7		
Pelleae spp										
Pelleae atropurpurea					<1	5				
Pellaea wrightiana					<1	5				
Pennelia micrantha					<1	5	<1	3		
Penstemon spp.							<1	3		
Penstemom barbatus			<1	20	<1	9	<1	10	<1	20
Penstemon linariodes					<1	10	<1	20		
Penstemon oligonathus										
Penstemom pseudospectabilis					1	5				
Penstemon virgatus										
Perityle ciliata										
Phacelia spp.									<1	20
Phacelia heterophylla										
Phaseolus spp.							<1	7	<1	20
Phaseolus wrightii					<1	9				
Phlox amabilis							<1	3		
Plantago patagonica										
Plummera floribunda	<1	50					<1	7		
Polemonium spp										
Polygala alba							<1	3		
Polygala longa										
Polygonum sawatchense							<1	17	<1	60
Potentilla spp.									<1	20
Potentilla hipplana										
Potentilla subviscosa										
Potentilla visidula			<1	10						
Pseudocymopterus montanus					<1	32	<1	10	<1	20
Psoralea tenuiflora									<1	20
Pteridium aquilinum			3	30	<1	18	2	10		
Pterospora andromedea					<1	5	<1	3		
Pyrola picta										
Salvia arizonica			<1	30						

Appendix B: Table 3 (continued)

Type No:	36		37		38		39		39b	
No. Plots:	(2)		(10)		(22)		(29)		(5)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Saxifraga erlophora										
Scrophularia parvifolia	<1	50			<1	5				
Sedum griffthsii										
Senecio eremophilus										
Senecio multilobatus							<1	3		
Senecio neomexicanus	<1	100	<1	10	<1	27	<1	45	<1	20
Senecio spartiodes										
Senecio wootoni					<1	5				
Silene laciniata	<1	50	<1	30						
Silene scouleri										
Sisymbrium linearifolium					<1	14	<1	3	<1	20
Smilacina stellata										
Solidago spp.							<1	7		
Solidago missouriensis										
Solidago sparsiflora	1	100	<1	10	<1	27	1	59		
Solidago wrightii			<1	30	<1	23	<1	7		
Sphaeralcea spp.							<1	3	<1	80
Sphaeralcea fendleri										
Stevia spp.			<1	10						
Stevia plummerae										
Stevia serrata			<1	10	<1	5				
Stelaria jamesiana										
Taraxacum officinale									<1	20
Thalictrum fendleri	2	50	<1	40	<1	23	<1	10		
Thelypodium longifolium							<1	3		
Thermopsis pinetorum							<1	3		
Townsendia exscapa										
Tragia ramosa					<1	5	<1	10	<1	40
Tragopogon pratensis									<1	20
Trifolium pinetorum										
Verbascum thapsus										
Verbena spp.			<1	10						
Verbena bipinnatifida							<1	3		
Vicia spp.			<1	10	<1	5				
Vicia americana	<1	50	<1	30	<1	5	<1	3		
Vicia pulchella			<1	20	<1	5				
Viguiera annua									<1	20
Viguiera multiflora			<1	10	<1	5	<1	3		
Viola canadensis							<1	7		
Woodsia mexicana	<1	50			<1	5				

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
TREES				
Abies concolor (yng. regen.)	4	5		
Abies concolor (adv. regen.)				
Acer grandidentatum (y.regen.)	1	5		
Acer grandidentatum (a.regen.)				
Acer negundo (mature)				
Alnus oblongifolia (mature)				
Arbutus arizonica (y. regen.)				
Arbutus arizonica (a. regen.)				
Arbutus arizonica (mature)				
Fraxinus pennsylvanica (y.reg)				
Fraxinus pennsylvanica (a.reg)				
Fraxinus pennsylvanica (matur)				
Juglans major (yng. regen.)	4	16		

Appendix B: Table 3 (continued)

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
Juglans major (adv.regen.)				
Juglans major (mature)				
Juniperus deppeana (y. regen.)	20	79	7	83
Juniperus deppeana (a. regen.)	3	63	4	67
Juniperus deppeana (mature)	2	11	1	33
Juniperus osteosperma (y. rg.)				
Juniperus osteosperma (ad.rg.)				
Juniperus scopulorum (y. rg.)	1	5		
Juniperus scopulorum (adv.rg.)				
Picea engelmannii (yng. regen)				
Pinus discolor (yng. regen.)				
Pinus discolor (adv. regen.)				
Pinus edulis (yng. regen.)	3	32	5	50
Pinus edulis (adv. regen.)	1	11	3	8
Pinus engelmannii (yng. regen)				
Pinus engelmannii (adv. regen)				
Pinus engelmannii (mature)				
Pinus leiophylla (yng. regen.)				
Pinus leiophylla (adv. regen.)				
Pinus leiophylla (mature)			1	8
Pinus monophylla (yng. reg.)			3	8
Pinus monophylla (mature)				
Pinus ponderosa (yng. regen.)	15	89	15	83
Pinus ponderosa (adv. regen.)	17	84	9	75
Pinus ponderosa (mature)	9	74	6	67
Pinus strobiformis (yng. reg.)				
Pinus strobiformis (adv. reg.)				
Pinus strobiformis (mature)				
Populus tremuloides (y. reg.)				
Pseudotsuga menziesii (y. reg)	2	11	2	8
Pseudotsuga menziesii (a. reg)	2	11		
Pseudotsuga menziesii (mature)	1	5		
Quercus arizonica (y. regen.)	8	74	9	75
Quercus arizonica (a. regen.)	12	79	9	75
Quercus arizonica (mature)	2	63	1	33
Quercus chrysolepis (y. reg.)			3	8
Quercus chrysolepis (a. reg.)			3	8
Quercus emoryi (y. regen.)	10	79	13	75
Quercus emoryi (a. regen.)	8	89	11	92
Quercus emoryi (mature)	1	16	2	17
Quercus gambelii (y. regen.)	2	11		
Quercus gambelii (a. regen.)	3	16		
Quercus gambelii (mature)				
Quercus hypoleucoides (y.reg.)			10	8
Quercus hypoleucoides (a.reg.)			2	8
Quercus hypoleucoides (mature)				
Quercus rugosa (y. regen.)				
Quercus rugosa (a. regen.)	3	5		
Quercus rugosa (mature)	1	5		
SHRUBS				
Acer grandidentatum	<1	5		
Agave spp.	<1	5		
Agave chrysantha				
Agave palmeri			<1	8
Agave parryi			<1	25
Amelanchier oreophila			1	8
Amorpha fruticosa			2	8
Apocynum androsaemifolium				

Appendix B: Table 3 (continued)

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
Arbutus arizonica				
Arctostaphylos pringlei	<1	5	8	83
Arctostaphylos pungens	<1	42	26	75
Artemisia tridentata				
Baccharis thesioides				
Brickellia californica				
Carphochaete bigelovii	<1	5	<1	8
Ceanothus fendleri	<1	63	<1	67
Ceanothus greggii				
Cercocarpus montanus	<1	32	<1	42
Cowania mexicana				
Fallugia paradoxa				
Fraxinus pennsylvanica				
Garrya flavescens				
Garrya wrightii	<1	53	<1	75
Gutirrezia lucida				
Holodiscus dumosus				
Hymenoxys richardsonii				
Hymenoxys rusbyi				
Lonicera spp.				
Lonicera albiflora	<1	5		
Lonicera arizonica			1	8
Berberis repens				
Mimosa biuncifera	<1	11		
Nolina microcarpa	1	5	<1	17
Opuntia spp.	<1	5		
Opuntia plumbea	<1	11	<1	8
Opuntia spinosior			<1	8
Opuntia whipiei				
Prunus serotina ssp. virens	<1	16	1	8
Prunus virginiana				
Ptelea angustifolia			1	8
Quercus arizonica	18	95	10	83
Quercus chrysolepis	<1	11	2	8
Quercus emoryi	11	100	11	92
Quercus gambelii	<1	37	<1	17
Quercus hypoleucoides			4	8
Quercus rugosa	4	16	<1	8
Quercus turbinella	<1	5	3	8
Rhamnus betulaefolia	<1	11	<1	8
Rhamnus crocea	<1	21	<1	25
Rhus aromatica	<1	21	1	8
Ribes cereum				
Robinia neomexicana	<1	11		
Rosa arizonica				
Rosa woodsii				
Rubus neomexicanus				
Salix pseudocordata				
Symphoricarpos oreophilus	<1	5		
Symphoricarpos parishii				
Symphoricarpos rotundifolius				
Toxicodendron rydbergii				
Vitis arizonica	<1	16		
Yucca baccata	<1	5	<1	8
Yucca schottii			<1	8
GRAMINOIDS				
Agropyron spp				
Agropyron arizonicum				

Appendix B: Table 3 (continued)

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
Agropyron subsecundum				
Schizachyrium spp				
Schizachyrium cirratum	<1	5		
Aristida spp.				
Aristida fendleriana				
Aristida arcuttiana	<1	26		
Blepharaneuran tricholepis				
Bautelaua curtipendula	<1	26		
Bautelaua gracilis	<1	21	<1	8
Bramus spp.				
Bramus tectarum				
Bromopsis richardsanii				
Bromapsis parteri				
Carex spp.	<1	16		
Carex geaphila	1	53	<1	25
Carex haodii				
Carex rassii	6	5	1	8
Cyperus spp.	<1	5		
Cyperus fendlerianus				
Cyperus rusbyi	<1	5		
Dactylis glamerata				
Festuca arizanica				
Kaeleria pyramidata	<1	21	<1	33
Lycurus phleaides	<1	5		
Muhlenbergia spp				
Muhlenbergia emersleyi	<1	16		
Muhlenbergia fragilis				
Muhlenbergia glauca				
Muhlenbergia langiligula	<1	79	4	17
Muhlenbergia mantana	<1	5	<1	8
Muhlenbergia racemisa				
Muhlenbergia virescens	<1	5		
Panicum bulbasum	<1	5		
Piptachaetium fimbriatum				
Paa spp				
Poa fendleriana	<1	58	2	33
Poa pratensis				
Schizacharium scoparium			<1	8
Setaria grisebachii				
Sitanian hystrix	<1	47	<1	25
Sparabalus spp				
Sporabalus interruptus				
Stipa calumbiana				
Stipa camata				
Stipa pringlei				
Stipa spp.				
FORBS				
Achillea millefalium	2	11		
Agaseris spp				
Amaranthus spp.				
Ambrasia psilastachya	<1	5		
Antennaria spp.				
Antennaria neglecta	<1	5	<1	8
Antennaria parvifalia	<1	5		
Antennaria rasulata				
Antherlcum tarreyl				
Arabls spp.				
Arenaria spp.				

Appendix B: Table 3 (continued)

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
Arenaria eastwoodiae				
Arenaria lanuginosa				
Artemisia carruthii	<1	11	<1	33
Artemisia dracunculoides				
Artemisia ludoviciana	<1	16		
Asclepias spp				
Astragulus spp.	<1	5	<1	33
Astragalus cobrensis				
Astragalus hallii	<1	5	<1	8
Astragulus humistratus				
Astragalus recurvus				
Astragalus tephrodes				
Aster bigelovii				
Aster commutatus				
Aster exilis				
Bahia dissecta	<1	5	<1	25
Bidens herterosperma				
Bidens lemmonii				
Brickellia spp.				
Brickellia betonieaefolia	<1	21		
Brickellia brachyphylla				
Brickellia fendleri				
Brickellia grandiflora				
Cacalia decomposita				
Calliandra humilis	<1	5	<1	8
Calliandra reticulata	<1	5		
Castilleja spp.	<1	8		
Castilleja austromontana				
Castilleja integra				
Castilleja linariafolia	<1	5		
Cerastium spp				
Chamaesaracha coronopus				
Cheilanthes fendleri	<1	5	<1	8
Chenopodium incisum				
Cirsium spp.				
Cirsium arizonicum				
Cirsium wheeleri				
Cirsium wrightii				
Cologania longifolia	<1	26		
Cologania pulchella	<1	5		
Cologania spp.				
Comandra umbellata s. pallida	<1	37	3	8
Commelina spp.				
Commelina dianthifolia	<1	11		
Commelina erecta				
Coralliorhiza striata				
Cystopteris fragilis				
Desmanthus cooleyi				
Desmodium sp.				
Desmodium batocaulon	<1	5		
Desmodium grahami	<1	5		
Desmodium rosei				
Draba helleriana				
Drymaria tenella				
Echinocactus spp.	<1	5		
Echinocereus spp.				
Epilobium paniculatum				
Erigeron spp.				
Erigeron caespitosus				

Appendix B: Table 3 (continued)

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
Erigeron divergens			<1	17
Erigeron flagellaris				
Erigeron formosissimus				
Erigeron neomexicanus	<1	11	<1	8
Erigeron nudiflorus	<1	11		
Erigeron oreophilus				
Erigeron rusbyi				
Erigeron speciosus				
Eriogonum alatum				
Eriogonum racemosum				
Euphorbia spp.				
Euphorbia brachycera				
Euphorbia chamaesula				
Euphorbia palmeri				
Fragaria americana				
Galactia wrightii				
Galium spp.	<1	11		
Galium asperrinum	<1	5		
Galium fendleri	<1	5		
Galium microphyllum	<1	11		
Galium rothroekii				
Galium wrightii				
Gaura gracilis				
Geranium caespitosum	<1	11	<1	8
Geranium ereophilum	<1	11		
Geranium richardsonii				
Gilia aggregata			<1	33
Gilia multiflora				
Gilia polyantha				
Gilia spp.				
Gnaphalium spp				
Gnaphalium arizonicum				
Gnaphalium macounii	<1	11		
Gnaphalium pringlei				
Gnaphalium wrightii				
Haploppappus spp.				
Hedeoma spp.				
Hedeoma dentatum			<1	8
Hedeoma hyssopifolium	<1	5		
Hedeoma oblongifolium				
Hedyotis pygmaea				
Heliopsis parvifolia				
Heterotheca fulcrata			<1	17
Heuchera parvifolia				
Hieraclum spp.				
Hieraclum carneum				
Hieraclum fendleri			<1	25
Hymenopappus filifolius lugens				
Hymenothrix wrightii				
Ipomea spp				
Ipomoea coccinea	<1	5		
Kuhnia rosmarinifolia	<1	11		
Lathyrus spp.				
Lathyrus arizonicus			<1	8
Lathyrus graminifolius	<1	5		
Lathyrus leucanthus	<1	11		
Lepedium spp				
Lepedium desiflorum				
Lepidium medium				

Appendix B: Table 3 (continued)

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
Lesquerella intermedia				
Leucelene ericoides	<1	5		
Linum aristatum				
Linum lewisia				
Linum neomexicanum			<1	25
Linum puberium				
Linum spp.				
Lithosperum incisum				
Lithosperum multiflorum	1	8		
Lotus wrightii	<1	37	<1	25
Lotus spp.				
Lupinus spp.	<1	5		
Lupinus argenteus				
Lupinus biumeri				
Lupinus hiiii	<1	5		
Lupinus kingsii				
Lupinus palmeri	<1	5		
Machaeranthera gracilis				
Malaxis soulei				
Mamalaria spp				
Mamalaria arizonica				
Meilotus officinalis				
Mirablis pumila	<1	5		
Monarda spp.			<1	17
Monarda menthafolia				
Monarda pectinata				
Monotropa hypopitys				
Oenothera spp.				
Osmorhiza chilensis				
Oxalis decaphylia				
Oxalis greyi				
Oxalis metcalfei				
Oxybaphus spp.				
Oxybaphus comatus				
Pedicularis spp.				
Pelleae spp.	<1	5		
Pelleae atropurpurea	<1	5		
Pellaea wrightiana				
Pennelia micrantha				
Penstemon spp.	<1	16	<1	17
Penstemom barbatus	<1	11	<1	8
Penstemon linariodes	<1	11	<1	17
Penstemon oligonathus				
Penstemom pseudospectabilis				
Penstemon virgatus	<1	11	<1	8
Perityle ciliata	<1	8		
Phacella spp				
Phacelia heterophylia	<1	8		
Phaseolus spp.	<1	8		
Phaseolus wrightii				
Phlox amabilis				
Plantago patagonica				
Plummera floribunda				
Polemonium spp				
Polygala alba				
Polygala longa				
Polygonum sawatchense	<1	21	<1	17
Potentilla spp.				
Potentilla hippiana				

Appendix B: Table 3 (continued)

Type No:	40		41	
No. Plots:	(19)		(12)	
	D/C	CON	D/C	CON
Potentilla subviscosa				
Potentilla visidula				
Pseudocymopterus montanus	<1	5	<1	8
Psoralea tenuiflora	<1	5		
Pteridium aquilinum	2	11		
Pterospora andromedea				
Pyrola picta				
Salvia arizonica				
Saxifraga eriophora				
Scrophularia parvifolia				
Sedum griffthsii				
Senecio eremophilus				
Senecio multilobatus	<1	5	<1	8
Senecio neomexicanus	<1	42	<1	67
Senecio spartiodes				
Senecio wootoni	1	5		
Silene laciniata	<1	5		
Silene scouleri				
Sisymbrium linearifolium	<1	11		
Smilacina stellata				
Solidago spp.	<1	5		
Solidago missouriensis				
Solidago sparsiflora	<1	74	<1	75
Solidago wrightii			<1	17
Sphaeralcea spp				
Sphaeralcea fendleri				
Stevia spp.				
Stevia plummerae				
Stevia serrata				
Stelaria jamesiana				
Taraxacum officinale				
Thalictrum fendleri	<1	5	<1	8
Thelypodium longifolium				
Thermopsis pinetorum				
Townsendia exscapa				
Tragia ramosa	<1	11		
Tragopogon pratensis				
Trifolium pinetorum				
Verbascum thapsus				
Verbena spp				
Verbena bipinnatifida	<1	5		
Vicia spp.				
Vicia americana				
Vicia pulchella				
Viguiera annua	<1	5		
Viguiera multiflora	<1	5		
Viola canadensis				
Woodsia mexicana	<1	5		

Table 4. Species average density (D) or cover (C) and constancy (CON) for the for the Pinus engelmannii and Pinus leiophylla series.

Type No. 42=Pinus engelmannii/Quercus rugosa HT
Type No. 43=Pinus engelmannii/Quercus hypoleucoides HT
Type No. 44a=Pinus engelmannii/Muhlenbergia longiligula HT M. longiligula PH
Type No. 44b=Pinus engelmannii/Muhlembergia longiligula HT Quercus arizonica PH
Type No. 44c=Pinus engelmannii/Muhlenbergia longiligula HT Quercus emoryi PH
Type No. 45=Pinus leiophylla/Quercus hypoleucoides HT
Type No. 46=Pinus leiophylla/Quercus arizonica HT
Type No. 47=Pinus leiophylla/Quercus emoryi HT
Type No. 48=Pinus leiophylla/Piptochaetium fimbriatum HT
Type No. 49=Pinus leiophylla/Arctostaphylos pungens HT

Type No:	42		43		44a		44b		44c	
No. Plots:	(1)		(6)		(1)		(1)		(1)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Arbutus arizonica (y. regen.)			1	17						
Arbutus arizonica (a. regen.)	2	100	4	17						
Arbutus arizonica (mature)										
Juniperus deppeana (y. regen.)			5	83	4	100	8	100	5	100
Juniperus deppeana (a. regen.)			1	17	25	100	3	100		
Juniperus deppeana (mature)							5	100		
Pinus discolor (yng. regen.)			3	50	3	100	8	100	38	100
Pinus discolor (adv. regen.)									5	100
Pinus edulis (yng. regen.)							39	100		
Pinus edulis (adv. regen.)							1	100		
Pinus engelmannii (yng. regen)			6	83	5	100	1	100	8	100
Pinus engelmannii (adv. regen)	1	100	3	67	2	100	5	100	14	100
Pinus engelmannii (mature)	3	100	5	100	2	100	5	100	5	100
Pinus leiophylla (yng. regen.)			4	50	8	100				
Pinus leiophylla (adv. regen.)			2	50	1	100				
Pinus leiophylla (mature)			3	17						
Pinus ponderosa (yng. regen.)										
Pinus ponderosa (adv. regen.)										
Pinus ponderosa (mature)										
Pinus strobiformis (yng. reg.)			1	17						
Platanus wrightii (yng.regen.)										
Platanus wrightii (adv.regen.)										
Platanus wrightii (mature)										
Pseudotsuga menziesii (y. reg)			3	17						
Pseudotsuga menziesii (a. reg)										
Quercus arizonica (y. regen.)	13	100	2	33						
Quercus arizonica (a. regen.)	4	100	6	50			5	100		
Quercus arizonica (mature)			1	17						
Quercus emoryi (y. regen.)									4	100
Quercus emoryi (a. regen.)									27	100
Quercus emoryi (mature)									1	100
Quercus hypoleucoides (y.reg.)	28	100	39	100						
Quercus hypoleucoides (a.reg.)	8	100	41	100						
Quercus hypoleucoides (mature)										
Quercus rugosa (y. regen.)	>100	100	1	17						
Quercus rugosa (a. regen.)	1	100	1	17						
SHRUBS										
Agave spp.										
Agave palmeri										
Agave parryi										
Arbutus arizonica	2	100	1	50						
Arctostaphylos pringlei										
Arctostaphylos pungens										
Baccharis thesioides					<1	100				
Bouvadia glaberrima	<1	17								
Brickellia californica										

Appendix B: Table 4 (continued)

Type No:	42		43		44a		44b		44c	
No. Plots:	(1)		(6)		(1)		(1)		(1)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Carphochaete bigelovii			<1	17					<1	100
Ceanothus fendleri			<1	33						
Ceanothus greggii			<1	17						
Cercocarpus montanus			<1	17	1	100				
Dasylirion wheeleri										
Dalea wislizeni										
Fallugia paradoxa									1	100
Fendlera rupicola										
Fraxinus pennsylvanica										
Garrya wrightii			<1	50			<1	100		
Juglans major							<1	100		
Juniperus deppeana (shrubs)			<1	17						
Lonicera arizonica							<1	100		
Mimosa biuncifera										
Mimosa grahamii										
Nolina microcarpa							1	100		
Opuntia spp.										
Opuntia engelmannii										
Opuntia plumbea										
Opuntia spinosior										
Platanus wrightii										
Prunus spp.										
Prunus serotina ssp. virens										
Ptelea angustifolia										
Quercus arizonica	4	100	5	83			9	100	<1	100
Quercus emoryi			<1	33			<1	100	40	100
Quercus gambelii			<1	17	1	100				
Quercus hypoleucoides	10	100	40	100	<1	100	<1	100		
Quercus rugosa	80	100	<1	17						
Quercus toumeyi			<1	17						
Quercus turbinella										
Rhamnus betulaefolia										
Rhus aromatica	<1	100	<1	33			<1	100	5	100
Rhus chorlophylla										
Robinia neomexicana					<1	100				
Selloa glutinosa										
Toxicodendron rydbergii										
Vitis arizonica							2	100	<1	100
Yucca baccata										
Yucca schottii			<1	33			<1	100		
GRAMINOIDS										
Agropyron arizonicum					5	100				
Agropyron desertorum										
Schizachyrium spp										
Schizachyrium cirratum										
Schizachyrium hirtiflorus										
Aristida spp.										
Aristida orcuttiana			<1	17			<1	100		
Blepharoneuron tricholepis										
Bouteloua barbatus										
Bouteloua curtipendula										
Bouteloua gracilis										
Bouteloua hirsuta										
Bromopsis richardsonii										
Bromopsis porteri	<1	17	<1	100						
Carex spp.	<1	17								
Carex geophila	<1	100	<1	33	<1	100	<1	100		
Cyperus spp.										

Appendix B: Table 4 (continued)

Type No:	42		43		44a		44b		44c	
No. Plots:	(1)		(6)		(1)		(1)		(1)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Cyperus rusbyi										
Eragrostis intermedia										
Koeleria pyramidata			<1	17	1	100				
Muhlenbergia emersleyi			2	33	5	100				
Muhlenbergia glauca										
Muhlenbergia longiligula	12	100	8	100	25	100	22	100	5	100
Muhlenbergia minutissima										
Muhlenbergia montana										
Muhlenbergia virescens										
Oryzopsis micrantha										
Panicum bulbosum			1	17	10	100				
Piptochaetium fimbriatum							2	100		
Poa fendleriana			<1	33	<1	100				
Schizachariun scoparium										
Setaria grisebachii										
Sitanion hystrix										
Sporobolus interruptus										
Stipa pringlei										
FORBS										
Achillea millefolium										
Allium kunthii										
Antennaria arida			<1	17						
Antennaria parvifolia										
Anthericum torreyi										
Arabis spp.			<1	17	<1	100				
Arabis tricornuta										
Artemisia carruthii										
Artemisia ludoviciana			<1	17	<1	100				
Artemisia spp.										
Asclepias tuberosa										
Astragulus spp										
Astragalus cobrensis										
Astragalus tephrodes										
Bahia dissecta					<1	100				
Bidens herterosperma										
Boerhaavia spp.										
Brickellia spp.									<1	100
Brickellia betonieaefolia										
Brickellia grandiflora										
Brickellia lemmoni										
Cacalia decomposita			<1	17						
Callandra humilis										
Callandra reticulata							<1	100		
Calliandra schottii							<1	100		
Cheilanthes fendleri			<1	33	<1	100				
Chenopodium fremontii										
Cologania longifolia			<1	17			<1	100		
Cologania pulchella										
Comandra umbellata s. pallida										
Commelina spp.			<1	17						
Commelina dianthifolia										
Conopholis mexicana										
Dalea leporina										
Desmodium sp.										
Desmodium arizonicum										
Desmodium batocaulon										
Desmodium grahami										
Desmodium rosei			<1	17						

Appendix B: Table 4 (continued)

Type No:	42		43		44a		44b		44c	
No. Plots:	(1)		(6)		(1)		(1)		(1)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Draba sp.										
Erigeron divergens										
Erigeron neomexicanus			<1	33						
Erigeron nudiflorus										
Erigeron oreophilus										
Eriogonum pharnaceoides										
Eriogonum wrightii										
Euphorbia spp.										
Euphorbia brachycera									<1	100
Euphorbia revoluta										
Galium spp.										
Galium asperrinum							<1	100	<1	100
Galium fendleri							<1	100	<1	100
Galium microphyllum										
Galium rothroekii										
Gentianella microcalyx							<1	100		
Geranium caespitosum									<1	100
Gilia macombii										
Gilia multiflora										
Gnaphalium spp										
Gnaphalium arizonicum										
Gnaphalium chilense										
Gnaphalium pringlei										
Gnaphalium wrightii										
Gutierrezia glutinosa										
Hedeoma dentatum										
Hedeoma hyssopifolium			1	17	1	100				
Hedeoma oblongifolium										
Hedyotis pygmaea							<1	100		
Heliopsis parvifolia										
Heterotheca fulcrata										
Hieracium carneum										
Hieracium fendleri			<1	33	<1	100				
Hymenopappus filifolius lugens										
Hymenothrix wrightii										
Ipomea spp										
Ipomoea coccinea										
Kuhnia rosmarinifolia										
Lathyrus graminifolius										
Leucelene ericoides										
Linum neomexicanum										
Lotus oroboides										
Lotus wrightii										
Lupinus blumeri			<1	17						
Malaxis soulei										
Monarda spp										
Monarda pectinata										
Oxalis decaphylla										
Oxybaphus spp.										
Oxytropus lambertii							<1	100		
Pelleae atropurpurea										
Pennelia micrantha			<1	17						
Penstemon spp										
Penstemom barbatus										
Penstemom pseudospectabilis										
Penstemon virgatus										
Perezia spp										
Phaseolus spp.									<1	100
Phaseolus acutifolius										

Appendix B: Table 4 (continued)

Type No:	42		43		44a		44b		44c	
No. Plots:	(1)		(6)		(1)		(1)		(1)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Phaseolus angustissimus										
Phaseolus wrightii										
Plummera floribunda							<1	100		
Polygala longa										
Polygala obscura										
Polygonum sawatchense										
Pseudocymopterus montanus			<1	17	<1	100				
Salvia lemmoni										
Scrophularia parvifolia										
Senecio eremophilus										
Senecio neomexicanus			<1	33			<1	100		
Senecio wootoni										
Sisymbrium linearifolium			<1	17					<1	100
Solidago spp.										
Solidago sparsiflora										
Solidago wrightii			<1	17			<1	100		
Stevia plummerae										
Stevia serrata			<1	17						
Taraxacum officinale										
Thalictrum fendleri			<1	17			<1	100		
Thelypodium longifolium			<1	17						
Thermopsis pinetorum					7	100				
Townsendia exscapa										
Tradescatia pinetorum							<1	100		
Verbena bipinnatifida										
Vicia americana					<1	100				
Viguiera dentata										
Viguiera multiflora										

Type No:	45		46		47		48		49	
No. Plots:	(9)		(10)		(6)		(7)		(9)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
TREES										
Arbutus arizonica (y. regen.)										
Arbutus arizonica (a. regen.)	3	44			1	17				
Arbutus arizonica (mature)	1	11	1	10						
Juniperus deppeana (y. regen.)	3	89	8	100	5	100	17	86	4	78
Juniperus deppeana (a. regen.)	4	44	3	80	4	67	12	71	2	56
Juniperus deppeana (mature)	2	11	2	30	2	71	1	22		
Pinus discolor (yng. regen.)	15	67	33	70	12	83	9	86	4	44
Pinus discolor (adv. regen.)	5	11	6	60	2	50	1	43	3	22
Pinus edulis (yng. regen.)										
Pinus edulis (adv. regen.)										
Pinus engelmannii (yng. regen)							3	29		
Pinus engelmannii (adv. regen)	3	11					3	14		
Pinus engelmannii (mature)							2	29		
Pinus leiophylla (yng. regen.)	6	78	5	80	6	100	10	100	9	100
Pinus leiophylla (adv. regen.)	10	100	6	80	5	100	5	100	10	100
Pinus leiophylla (mature)	6	100	3	90	3	100	3	100	3	100
Pinus ponderosa (yng. regen.)	21	11	14	30	21	33			22	56
Pinus ponderosa (adv. regen.)	11	11	11	30	9	17			6	56
Pinus ponderosa (mature)	1	11	1	10	2	17			1	33
Pinus strobiformis (yng. reg.)										
Platanus wrightii (yng.regen.)							3	14		
Platanus wrightii (adv.regen.)							1	14		
Platanus wrightii (mature)							3	29		
Pseudotsuga menziesii (y. reg)	1	11	2	20						
Pseudotsuga menziesii (a. reg)	1	11	1	10						

Appendix B: Table 4 (continued)

Type No:	45		46		47		48		49	
No. Plots:	(9)		(10)		(6)		(7)		(9)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Quercus arizonica (y. regen.)	2	56	3	60	2	83	3	29	4	44
Quercus arizonica (a. regen.)	7	89	22	100	8	83	8	100	4	33
Quercus arizonica (mature)	1	11	4	40	1	17	2	100	1	22
Quercus emoryi (y. regen.)	2	33	2	30	6	83	1	29	1	22
Quercus emoryi (a. regen.)	2	33	2	30	12	83	2	43	5	33
Quercus emoryi (mature)					6	50	1	14		
Quercus hypoleucoides (y.reg.)	42	100	11	90	5	67	28	57	19	44
Quercus hypoleucoides (a.reg.)	22	89	7	60	4	67	8	29	17	33
Quercus hypoleucoides (mature)									1	11
Quercus rugosa (y. regen.)										
Quercus rugosa (a. regen.)										
SHRUBS										
Agave spp.	<1	11							<1	11
Agave palmeri	<1	17	<1	14	<1	11				
Agave parryi	<1	44	<1	30	<1	33	<1	14	<1	11
Arbutus arizonica	3	44	3	10					<1	11
Arctostaphylos pringlei	<1	22	4	20	1	17			8	56
Arctostaphylos pungens	2	44	3	40	8	83	<1	43	17	89
Baccharis thesioides										
Bouvadia glaberrima							<1	14		
Brickellia californica									<1	11
Carphochaete bigelovii	<1	44			2	17			<1	44
Ceanothus fendleri	<1	22	<1	40	1	17	<1	14	3	33
Ceanothus greggii							<1	14		
Cercocarpus montanus			3	10	<1	17				
Dasylirion wheeleri	<1	11								
Dalea wislizeni			<1	10					<1	11
Fallugia paradoxa										
Fendlera rupicola									<1	22
Fraxinus pennsylvanica	<1	11	<1	10			<1	14		
Garrya wrightii	<1	33	<1	50	1	33	1	29	<1	33
Juglans major							<1	14		
Juniperus deppeana (shrubs)	<1	11	<1	20	3	33	<1	67		
Lonicera arizonica			<1	10					<1	11
Mimosa biuncifera					<1	33			<1	11
Mimosa grahamii			<1	10						
Nolina microcarpa	2	44	6	60	6	50	<1	14	1	33
Opuntia spp.	<1	11	<1	30			<1	14	<1	11
Opuntia engelmannii			<1	10						
Opuntia plumbea	<1	11	<1	20	<1	33				
Opuntia spinosior					<1	33	<1	29		
Platanus wrightii							8	29		
Prunus spp.			<1	10						
Prunus serotina ssp. virens							3	57	1	11
Ptelea angustifolia							<1	14		
Quercus arizonica	4	100	23	100	7	100	17	100	4	67
Quercus emoryi	3	33	1	50	17	100	3	71	2	44
Quercus gambelii			<1	20					<1	22
Quercus hypoleucoides	26	100	10	80	4	83	12	71	15	44
Quercus rugosa	<1	11					2	14		
Quercus toumeyi	1	11			5	17	6	22		
Quercus turbinella	10	17								
Rhamnus betulaefolia			3	20			2	71	<1	11
Rhus aromatica	<1	44	2	50	1	50	6	86	2	22
Rhus choriophylla	<1	11			1	17	1	14	<1	11
Robinia neomexicana			<1	10			1	14		
Selloa glutinosa			<1	10			<1	14		
Toxicodendron rydbergii							<1	14		

Appendix B: Table 4 (continued)

Type No: / No. Plots:	45 (9)		46 (10)		47 (6)		48 (7)		49 (9)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Vitis arizonica			<1	10			2	86	1	11
Yucca baccata	1	11								
Yucca schottii	<1	33	1	60	1	17	<1	57	<1	33
GRAMINOIDS										
Agropyron arizonicum										
Agropyron desertorum									<1	22
Schizachyrium spp.			<1	10						
Schizachyrium cirratum	<1	22	<1	30	4	67			<1	44
Schizachyrium hirtiflorus					1	17				
Aristida spp.							<1	17		
Aristida orcuttiana	<1	44	<1	60	4	83	<1	86	3	78
Blepharoneuron tricholepis									<1	33
Bouteloua barbatus									<1	22
Bouteloua curtipendula					1	50	2	71	<1	11
Bouteloua gracilis					<1	17	1	14		
Bouteloua hirsuta					<1	17			<1	11
Bromopsis richardsonii	<1	11								
Bromopsis porteri			<1	10			<1	29		
Carex spp.			<1	10			2	43	<1	56
Carex geophila	<1	44	2	50	1	33	<1	22		
Cyperus spp.							<1	14		
Cyperus rusbyi							<1	14	<1	33
Eragrostis intermedia					<1	17				
Koeleria pyramidata			<1	40	3	33			<1	33
Muhlenbergia emersleyi	2	22	<1	10	6	83	8	14	5	22
Muhlenbergia glauca	2	14								
Muhlenbergia longiligula	6	89	11	90	18	83	2	86	5	67
Muhlenbergia minutissima							<1	14		
Muhlenbergia montana									<1	44
Muhlenbergia virescens	<1	11							<1	11
Oryzopsis micrantha					7	17				
Panicum bulbosum	<1	11	<1	30	<1	17	3	43	1	11
Piptochaetium fimbriatum	<1	11	<1	60	<1	17	40	100	<1	11
Poa fendleriana			<1	20	<1	33			<1	44
Schizacharium scoparium							<1	33		
Setaria grisebachii							<1	14		
Sitanion hystrix			<1	10					<1	22
Sporobolus interruptus			<1	10						
Stipa pringlei					4	17	<1	14		
FORBS										
Achillea millefolium							1	14		
Allium kunthii	<1	11	<1	10						
Antennaria arida										
Antennaria parvifolia			<1	10					<1	11
Anthericum torreyi			<1	10						
Arabis spp.							<1	29		
Arabis tricornuta					<1	17				
Artemisia carruthii	<1	11	<1	10						
Artemisia ludoviciana	<1	11			<1	17	<1	29		
Artemisia spp.					<1	17				
Asclepias tuberosa			<1	10						
Astragulus spp.	<1	11	<1	10						
Astragalus cobrensis							<1	29	<1	11
Astragalus tephrodes									<1	11
Bahia dissecta	<1	11	<1	50					<1	33
Bidens herterosperma							<1	14		
Boerhaavia spp.			<1	10						

Appendix B: Table 4 (continued)

Type No: / No. Plots:	45 (9)		46 (10)		47 (6)		48 (7)		49 (9)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Brickellia spp.									<1	11
Brickellia betonieaefolia			<1	10	<1	17				
Brickellia grandiflora	<1	11	<1	10			<1	29		
Brickellia lemmoni	<1	11	<1	10	<1	17	<1	43		
Cacalia decomposita	<1	11					1	14		
Calliandra humilis			<1	20	<1	17	<1	14		
Calliandra reticulata	<1	22	<1	20	<1	17	1	29	<1	56
Calliandra schottii	<1	11							<1	11
Cheilanthes fendleri	<1	33	<1	30	<1	33			<1	22
Chenopodium fremontii					<1	17				
Cologania longifolia	<1	11	<1	20	<1	17	5	14	<1	11
Cologania pulchella	<1	11								
Comandra umbellata s. pallida			<1	20	<1	17			<1	33
Commelina spp.										
Commelina dianthifolia			<1	10			<1	14	<1	11
Conopholis mexicana			<1	10						
Dalea leporina			<1	10						
Desmodium sp.			<1	10						
Desmodium arizonicum							<1	29		
Desmodium batocaulon							<1	14		
Desmodium grahami					<1	17	<1	29		
Desmodium rosei	<1	22	<1	20			<1	43	<1	11
Draba sp.									<1	11
Erigeron divergens									<1	44
Erigeron neomexicanus	<1	11	<1	20	<1	17	<1	14	<1	22
Erigeron nudiflorus							1	14		
Erigeron oreophilus	<1	11								
Eriogonum pharnaceoides									<1	11
Eriogonum wrightii					<1	17				
Euphorbia spp.									<1	11
Euphorbia brachycera					<1	17	<1	29		
Euphorbia revoluta							<1	14		
Galium spp.					<1	17				
Galium asperrinum	<1	11					<1	29		
Galium fendleri	<1	11								
Galium microphyllum	<1	11	<1	10			<1	57		
Galium rothroekii									<1	11
Gentianella microcalyx							<1	14		
Geranium caespitosum							<1	14		
Gilia macombii							<1	14		
Gilia multiflora									<1	33
Gnaphalium spp.	<1	11								
Gnaphalium arizonicum	<1	10	<1	33	<1	14	<1	33		
Gnaphalium chilense			<1	10						
Gnaphalium pringlei	<1	11	<1	10						
Gnaphalium wrightii	<1	22	<1	30	<1	17	<1	29	<1	11
Gutierrezia glutinosa			<1	20						
Hedeoma dentatum	<1	11	<1	10						
Hedeoma hyssopifolium	<1	22	1	10	<1	17	<1	14	<1	56
Hedeoma oblongifolium					<1	17				
Hedyotis pygmaea			<1	10						
Heliopsis parvifolia			<1	10			<1	14		
Heterotheca fulcrata					<1	17			<1	11
Hieracium carneum			<1	10						
Hieracium fendleri	<1	11					<1	14	<1	33
Hymenopappus filifolius lugens									<1	33
Hymenothrix wrightii					<1	17				
Ipomea spp.							<1	14		
Ipomoea coccinea							<1	14		

Appendix B: Table 4 (continued)

Type No:	45		46		47		48		49	
No. Plots:	(9)		(10)		(6)		(7)		(9)	
	D/C	CON	D/C	CON	D/C	CON	D/C	CON	D/C	CON
Kuhnia rosmarinifolia	<1	11	<1	10	<1	17	<1	14		
Lathyrus graminifolius					<1	33				
Leucelene ericoides									<1	22
Linum neomexicanum	<1	22	<1	30	<1	17	<1	22		
Lotus oroboides	<1	11								
Lotus wrightii	<1	11	<1	20					<1	33
Lupinus blumeri	<1	11								
Malaxis soulei							<1	14		
Monarda spp.							<1	14		
Monarda pectinata							<1	43		
Oxalis decaphylla							1	29		
Oxybaphus spp.									<1	11
Oxytropus lambertii	<1	11	<1	10						
Pelleae atropurpurea									<1	11
Pennella micrantha					<1	33			<1	11
Penstemon spp.									<1	33
Penstemom barbatus	<1	22	<1	10			<1	14	<1	22
Penstemom pseudospectabilis					3	17				
Penstemon virgatus					<1	17				
Perezia spp.									<1	11
Phaseolus spp.							<1	14		
Phaseolus acutifolius							<1	14		
Phaseolus angustissimus							<1	14		
Phaseolus wrightii	<1	22	<1	10			<1	43	<1	22
Plummera floribunda			<1	10	<1	17				
Polygala longa	<1	11	<1	20						
Polygala obscura					<1	17				
Polygonum sawatchense							<1	11		
Pseudocymopterus montanus			<1	10						
Salvia lemmoni			<1	10						
Scrophularia parvifolia							<1	11		
Senecio eremophilus			<1	10						
Senecio neomexicanus	<1	44	<1	50	<1	67	<1	57	<1	67
Senecio wootoni	<1	11					<1	14		
Sisymbrium linearifolium	<1	11	<1	10	<1	17	<1	44		
Solidago spp.							<1	14		
Solidago sparsiflora	<1	11	1	30					1	44
Solidago wrightii			<1	10	<1	17	5	14	<1	11
Stevia plummerae							<1	14		
Stevia serrata	<1	11	<1	10			<1	14		
Taraxacum officinale							<1	14		
Thalictrum fendleri							<1	29		
Thelypodium longifolium										
Thermopsis pinetorum									<1	11
Townsendia exscapa									<1	11
Tradescatia pinetorum							<1	14		
Verbena bipinnatifida			<1	20	<1	33				
Vicia americana										
Viguiera dentata					1	17	2	14		
Viguiera multiflora	<1	11			<1	17	<1	14	<1	11

APPENDIX C

Tree Successional Status

Successional status of canopy (table 1a) and subcanopy (table 2b) trees within forest habitat types south of the Mogollon Rim in Arizona.

C = Major Climax Species S = Major Successional Species

c = Minor Climax Species s = Minor Successional Species

a = Accidental

Values in parentheses refer to species that could potentially be present based on literature, which have not been recorded in the present study.

See text table 2 for habitat type abbreviations and Appendix A for species acronym definitions.

Table 1a. Succesional status of canopy trees within forest habitat types south of the Mogollon Rim.

Habitat type	Species									
	PIEN	ABLA	PIPU	ABCO	PSME	PIST	PIPO	PINEN	PILE	POTRI
PIEN/Moss	C	a								(s)
PIEN/CAFO	C	a								(s)
PIEN/ACGL	C			c	C	s				S
PIEN/EREX	C		c	c	C	s	s			S
ABLA/Moss	C	C			s					(s)
ABLA/VAMY	C	C			(s)					(s)
ABLA/VAMY-RUPA	C	C			(s)					(S)
ABLA/RUPA	C	C			(s)					(S)
ABLA/EREX	C	C	(s)	(s)	s	(s)				S
ABLA/JAAM		C		s	S					S
PIPU/FEAR	c	a	C	(c)	c	s	s			S
PIPU/JUCO	c		C	(s)	C	s				s
PIPU/EREX	c		C	(c)	C	(s)	s			(S)
ABCO/VAMY				C	C	c	s			
ABCO/CAFO	a	c		C	C	s	s			S
ABCO/BERE				C	C	s	(s)			s
ABCO/ACGL		a		C	C	s	(s)			S
ABCO/EREX VAAR ph				C	C	S	s			(S)
ABCO/QUGA				C	C	S	S			s
ABCO/ACGR				C	C	c	s			
ABCO/JUMA				C	c		s			
PSME/Sparse				c	C	c				
PSME/MUVI				c	C	c	c			
PSME/MUMO					C	s				s
PSME/QUGA				a	C	s	S			
PSME/ACGR					C		s			
PSME/QURU				(a)	C	S	S			
PSME/QUHY				a	C	a	S			
PSME/QUAR				a	C		C			
PIPO/FEAR				C			(s)			
PIPO/MUVI					(a)		c	C		

Appendix C: Table 1a (continued)

Habitat type	Species									
	PIEN	ABLA	PIPU	ABCO	PSME	PIST	PIPO	PINEN	PILE	POTRI
PIPO/MUMO						(a)		c		
PIPO/QUGA										
QUGA ph						a	c	C		
BOGR ph								C		
PIED ph								C		
MULO ph								C		
PIPO/BOGR										
BOGR ph								C		
ARTR ph								C		
PIPO/JUMA						a		C		
PIPO/ACGR								C		
PIPO/QURU						a	c	C		a
PIPO/QUHY						a	c	C	a	a
PIPO/QUAR										
QUAR ph						a		C		
BOGR ph								C		
PIPO/QUEM						a		C		
PIPO/ARPU						a		C		a
PINEN/QURU								(a)	C	
PINEN/QUHY									C	s
PINEN/MULO										
MULO ph									C	
QUAR ph									C	s
QUER ph									C	a
PILE/QUHY						a		c		C
PILE/QUAR						a		c		C
PILE/QUEM								c		C
PILE/PIFI								(c)	c	C
PILE/ARPU								c		C

TABLE 1b. Succesional status of subcanopy trees within forest habitat types south of the Mogollon Rim.

Habitat type	PIDI	PIED	JUDE	JUOS	JUSC	QUGA	QURU	QUHY	QUAR	QUEM	JUMA	ACGL	ACGR
PIEN/Moss													
PIEN/CAFO													
PIEN/ACGL												C	
PIEN/EREX													
ABLA/Moss													
ABLA/VAMY													
ABLA/VAMY-RUPA													
ABLA/RUPA													
ABLA/EREX													
ABLA/JAAM													
PIPU/FEAR													
PIPU/JUCO													
PIPU/EREX													
ABCO/ACGL												C	
ABCO/QUGA			s			S							
ABCO/ACGR						s					s		C
ABCO/BERE													
ABCO/EREX													
VAAR ph						s							
ABCO/CAFO													
ABCO/JUMA						s					S		
ABCO/VAMY						s							
PSME/Sparse						s							
PSME/MUVI						a	a		a				
PSME/MUMO													
PSME/QUGA			s			S	s	s					
PSME/QURU			a			a	S	s	a				
PSME/QUHY	s		s			a	s	S	S				
PSME/QUAR	s		s			a			S				
PSME/ACGR	s		s			s	s	s	s				C
PIPO/FEAR													
PIPO/MUVI	a		s			s	s	s					
PIPO/QUGA													
QUGA ph	a	a	c			S	a		a				
BOGR ph		s	c	c		S			a				
PIED ph		c	c	c		S							
MULO ph	s		c			S	a	s	a				
PIPO/BOGR													
BOGR ph		c	c	c	a	s							
ARTR ph		c		c		s							
PIPO/QURU	s		a			a	C	c	a				
PIPO/QUHY	s		c			a	a	C	S				
PIPO/QUAR													
QUAR ph	c	c	C			a	(a)	a	C	c			
BOGR ph		c	C						C	s			
PIPO/QUEM		c	C			a			C	C			
PIPO/ARPU	(c)	c	C			a		a	c	c			
PIPO/JUMA		s	c	(s)	s	s			s		S		
PIPO/MUMO	c	c	c			s							
PIPO/ACGR						s	s	s			c		C
PINEN/QURU							C	c	s				
PINEN/QUHY	c		c				a	C	c				
PINEN/MULO													
MULO ph	c		c					a	(a)				
QUAR ph	c		C						C				
QUEM ph	C		c							C			
PILE/QUHY	C		C					C	c	s			
PILE/QUAR	C		C					c	C	s			
PILE/QUEM	C		C					c	c	C			
PILE/PIFI	C		C					S	s	s	s		
PILE/ARPU	C		C					c	c	c			

APPENDIX D

Key to the Forest Series and Habitat Types of Southern Arizona and Portions of the Colorado Plateau

When identifying habitat types in the field, the descriptive text descriptions, and Appendix tables, as well as this Key will be useful in for determining the correct type. Ideally, since the classification was developed using mature, late seral or climax, minimally disturbed stands, identification of habitat types using the keys and text descriptions is best achieved through examining undisturbed vegetation. However, habitat types can usually be identified even in seral stands by noting the relative reproductive success of the species present, or by comparison with adjacent mature stands having similar topographic and edaphic features (Arno 1982; Pfister et al. 1977).

Field identification of habitat types using this report can best be accomplished in the following way:

1. Locate a portion of the stand that best represents the typical vegetation. The tree canopy should be mature and the undergrowth should not be severely disturbed. Extrapolation from the nearest mature stand occupying a similar site may be necessary in some disturbed areas.
2. Note mature trees and the status of their reproduction by species within the stand. Reference to trees in the key primarily concerns regeneration since habitat types are based on "potential" climax, not necessarily current vegetation conditions.
3. Accurately identify the dominant shrub and herb species within the stand, and estimate the cover of each. Note the presence of indicator species given in the key that may exhibit only minor coverage in the sampled stand.
4. Note the physical setting of the stand including elevation, aspect, percent slope, landform, and soil depth and coarse fragment content.
5. Identify the habitat type by following the dichotomous key.
6. If difficulty arises in habitat type identification, compare the stand with the synoptic descriptions and with the species frequency and cover tables given for the series and types in question. Then decide which best fits the stand characteristics.
7. The key provided here is comprehensive for the Tonto, Prescott and Coronado National Forests; and the Fort Apache, San Carlos and Hualapai Indian Reservations.
8. If it becomes apparent that an undescribed habitat type has been found, the stand should be measured thoroughly and its precise location given to the U.S. Forest Service regional ecologist. Terms used in the key to describe canopy coverage are defined below. In stands where dense shading or heavy litter accumulation has resulted in an unusually sparse undergrowth, adjust apply the next lower coverage class in the key.

Absent—individuals are not found in the habitat type (opposite = present).
Present—is an associate of the habitat type.
Accidental—individuals are very infrequent, occasional, or limited to special microsites.
Abundant—canopy coverage > 25%.
Common—canopy coverage > 1%.
Dominant—density or cover is as great as, or greater than, any other species of the same life form.
Luxuriant—canopy coverage > 50%.
Poorly-represented—canopy coverage < 5%.
Scarce—canopy coverage < 1% (opposite = common).
Well represented—canopy coverage > 5%.

Series Key

1. *Picea pungens* present, neither accidental nor seral; density of *Picea pungens* regeneration over twice that of either *Picea engelmannii* or *Abies lasiocarpa* ..... **Picea pungens Series**

1. *Picea pungens* absent, accidental or seral; density of *Picea pungens* regeneration less than twice that of either *Picea engelmannii* or *Abies lasiocarpa* 2

2. *Picea engelmannii* and/or *Abies lasiocarpa* climax, regeneration clearly not accidental ..... **Picea engelmannii or Abies lasiocarpa Series**

2. *Picea engelmannii* or *Abies lasiocarpa* absent, scarce, or minor regeneration relative to other conifers 3

3. *Abies concolor* present and reproducing successfully; usually codominant with *Pseudotsuga menziesii* ..... **Abies concolor Series**

3. *Abies concolor* absent, scarce, or minor relative to other conifers 4

4. *Pseudotsuga menziesii* present and reproducing successfully; sometimes codominant with *Pinus strobiformis* ..... **Pseudotsuga menziesii Series**

4. *Pseudotsuga menziesii* scarce or absent 5

5. *Pinus leiophylla* or *Pinus engelmannii* present and reproducing successfully ..... **Pinus engelmannii or Pinus leiophylla Series**

5. *Pinusleiophylla* or*Pinus elmannii* absent or scarce ..... **Pinus ponderosa Series**

Habitat Type Keys

See table 2 of text for definitions of habitat type abbreviations used in the key.

***Picea engelmanii* and *Abies lasiocarpa* Series**

1. *Abies lasiocarpa* present and successfully reproducing 2

1. *Abies lasiocarpa* scarce or absent 7

2. *Vaccinium myrtillus* well represented 3

2. *Vaccinium myrtillus* poorly represented or absent 4

3. *Rubus parviflorus* well represented ..... **ABLA/VAMY-RUPA HT**

3. *Rubus parviflorus* poorly represented or absent ..... **ABLA/VAMY HT**

4. *Jamesia americana* well represented ..... **ABLA/JAAM HT**

4. *Jamesia americana* poorly represented or absent 5

5. *Rubus parviflorus* well represented ..... **ABLA/RUPA HT**

5. *Rubus parviflorus* poorly represented or absent 6

6. *Erigeron eximius* well represented ..... **ABLA/EREX HT**

6. *Erigeron eximius* poorly represented ..... **ABLA/Moss HT**

7. *Acer glabrum* well represented ..... **PIEN/ACGL HT**

7. *Acer glabrum* poorly represented 8

8. Undergrowth relatively well-developed; at least one species common 9

8. Vascular plant undergrowth very sparse; no species common ..... **PIEN/Moss HT**

9. Undergrowth dominated by forbs, *Erigeron eximius* usually well represented ..... **PIEN/EREX HT**

9. Undergrowth graminoid dominated, Carex foenea usually well represented ..... **PIEN/CAFO HT*Picea pungens* Series**

1. *Juniperus communis* well represented ..... **PIPU/JUCO HT**

1. *Juniperus communis* absent or scarce 2
2. Undergrowth dominated by perennial forbs, luxuriant ..... **PIPU/EREX HT**
2. Undergrowth clearly dominated by grasses, *Festuca arizonica* well represented ..... **PIPU/FEAR HT**

***Abies concolor* Series**

1. *Vaccinium myrtillus* well represented ..... **ABCO/VAMY HT**
1. *Vaccinium myrtillus* poorly represented or absent 2
2. *Acer grandidentatum* well represented ..... **ABCO/ACGR HT**
2. *Acer grandidentatum* poorly represented or absent 3
3. *Acer glabrum* well represented; the dominant shrub ..... **ABCO/ACGL HT**
3. *Acer glabrum* poorly represented or absent; not dominant 4
4. *Juglans major, Acer negundo*, or *Fraxinus pennsylvanica* common, alluvial terraces ..... **ABCO/JUMA HT**
4. *Juglans major, Acer negundo*, or *Fraxinus pennsylvanica* absent or minor, land forms other than alluvial terrace 5
5. *Quercus gambelii* well represented ..... **ABCO/QUGA HT**
5. *Quercus gambelii* poorly represented or absent 6
6. Undergrowth very sparse; total vascular plant cover low ..... **ABCO/BERE HT**
6. Undergrowth herbaceous, luxuriant or *Carex foenea* well represented 7
3. Undergrowth graminoid dominated, *rex foenea* abundant ..... **ABCO/CAFO HT**
3. Undergrowth forb dominated, *Valeriana* spp. or *Erigeron eximius* well represented, *Carex foenea* less than 25% cover; not dominant ..... **ABCO/EREX HT**

***Pseudotsuga menziesii* Series**

1. *Acer grandidentatum* well represented ..... **PSME/ACGR HT**
1. *Acer grandidentatum* poorly represented or absent 2
2. *Muhlenbergia virescens* well represented ..... **PSME/MUVI HT**
2. *Muhlenbergia virescens* poorly represented or absent 3
3. *Quercus* species common 4
3. *Quercus species* scarce or absent 7
4. *Quercus gambelii* well represented; the dominant oak ..... **PSME/QUGA HT**
4. *Quercus gambelii* poorly represented or absent; not dominant 5
5. *Quercus rugosa* well represented; the dominant oak ..... **PSME/QURU HT**
5. *Quercus rugosa* poorly represented or absent; not dominant 6
6. *Quercus hypoleucoides* well represented ..... **PSME/QUHY HT**
6. *Quercus hypoleucoides* poorly represented or absent ..... **PSME/QUAR HT**
7. *Muhlenbergia montana* well represented ..... **PSME/MUMO HT**
7. *Muhlenbergia montana* poorly represented or absent; very low vascular plant cover ..... **PSME/SPARSE HT**

***Pinus ponderosa* Series**

1. *Acer grandidentatum* well represented	**PIPO/ACGR HT**
1. *Acer grandidentatum* poorly represented or absent	**2**
2. *Juglans major* well represented; semiriparian forests of alluvial flats and benches	**PIPO/JUMA HT**
2. *Juglans major* poorly represented; nonriparian forests	**3**
3. *Arctostaphylos* spp. well represented	**PIPO/ARPU HT**
3. *Arctostaphylos* spp. poorly represented or absent	**4**
4. *Festuca arizonica* common	**PIPO/FEAR**
4. *Festuca arizonica* absent or scarce	**5**
5. *Muhlenbergia virescens* well represented	**PIPO/MUVI HT**
5. *Muhlenbergia virescens* poorly represented or absent	**6**
6. *Quercus* species poorly represented or absent	**7**
6. *Quercus* species well represented	**8**
7. *Muhlenbergia montana* well represented; the dominant grass	**PIPO/MUMO HT**
7. *Muhlenbergia montana* poorly represented or absent; not do *Caminant*	**PIPO/BOGR HT**
8. *Quercus gambelii* well represented	**PIPO/QUGA HT**
8. *Quercus gambelii* poorly represented or absent	**9**
9. *Bouteloua gracilis* well represented	**PIPO/BOGR HT**
9. *Bouteloua gracilis* uncommon or absent	**10**
10. *Quercus rugosa* well represented	**PIPO/QURU HT**
10. *Quercus rugosa* poorly represented or absent	**11**
11. *Quercus hypoleucoides* well represented; the dominant oak	**PIPO/QUHY HT**
11. *Quercus hypoleucoides* poorly represented and subdominant, or absent	**12**
12. *Quercus emoryi* well represented	**PIPO/QUEM HT**
12. *Quercus emoryi* poorly represented or absent	**PIPO/QUAR HT**

***Pinus engelmanii* and *Pinus leiophylla* Series**

1. *Arctostaphylos* species well represented; the dominant shrubs	**PILE/ARPU HT**
1. *Arctostaphylos* species poorly represented and subdominant, or absent	**2**
2. *Piptochaetium fimbriatum* well represented	**PILE/PIFI HT**
2. *Piptochaetium fimbriatum* poorly represented	**3**
3. *Pinus engelmannii* present and reproducing successfully	**4**
3. *Pinus engelmannii* absent or scarce	**6**
4. *Quercus rugosa* well represented	**PINEN/QURU HT**
4. *Quercus rugosa* poorly represented or absent	**5**
5. *Quercus hypoleucoides* well represented; the dominant oak	**PINEN/QUHY HT**
5. *Quercus hypoleucoides* poorly represented and subdomninat, or absent	**PINEN/MULO HT**
6. *Quercus hypoleucoides* well represented; the dominant oak	**PILE/QUHY HT**
6. *Quercus hypoleucoides* poorly represented and subdominant, or absent	**7**
6. *Quercus emoryi* well represented	**PILE/QUEM HT**
6. *Quercus emoryi* poorly represented or absent	**PILE/QUAR HT**

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